

Government of Peoples Republic of Bangladesh

Chattogram Water Supply and Sewerage Authority



Chattogram Water Supply Improvement Project (CWSIP)

IDA Credit No. 7675-BD & 7674-BD

**Request for Proposals
for**

**Design, Construction, Supply, Installation, Testing &
Commissioning for System Improvement and DMA Formation of**

Lot 1: Mohara Water Supply System

Lot 2: Modunaghat and Kalurghat Water Supply System

Volume-1-Part 1+Part 3

Volume 2A and 2B- Employer's Requirements

Volume-3A and 3B- Conceptual Drawing

Volume-4- Supplementary Information

RFP No: CWSIP/W1

Issued on: 12/07/2026

Request for Proposals Works

Design and Build

(Single-Stage Request for Proposals, without Initial Selection)

Procurement of:

**Lot-2) Construction, Design, Supply, Installation, Testing
& Commissioning for System Improvement and DMA
Formation of Modunaghat & Kalurghat Water Supply
System**

Employer: Chattogram Water Supply and Sewerage Authority

Project: Chattogram Water Supply Improvement Project (CWSIP)

Contract(s) title:

Lot-1) Construction, Design, Supply, Installation, Testing &
Commissioning for System Improvement and DMA
Formation of MOHARA Water Supply System

and

Lot-2) Construction, Design, Supply, Installation, Testing &
Commissioning for System Improvement and DMA
Formation of Modunaghat & Kalurghat Water Supply System

Country: People's Republic of Bangladesh

Loan No./Credit No./Grant No.: IDA Credit No. 7675-BD & 7674-BD

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PART 2 –EMPLOYER’S REQUIREMENTS

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**SECTION VII-L2. EMPLOYER'S REQUIREMENTS -
LOT2**

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SECTION VII-L2. EMPLOYER'S REQUIREMENTS- LOT2

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L2-1 ENVIRONMENTAL AND SOCIAL (ES) REQUIREMENTS

2.1 Introduction

During implementation of the contract, the contractor is required to comply with the environmental and social regulations and standards to meet the requirements of the government law and the World Bank. The contractor would prepare an Environmental and Social Management Plan (C-ESMP) including a Health and Safety Management Plan for this purpose as per but not limited to the provisions of the particular conditions of contract and the requirements mentioned in this section and submit the same for approval of the Project Manager before mobilization of the work. The C-ESMP would be living document and to be updated as and when necessary as approved by the engineer.

During implementation of the Contract, the Contractor shall comply with:

- a) Applicable laws and regulations of the Government of Bangladesh;
- b) The World Bank Environmental and Social Framework (ESF); and
- c) The provisions of the General Conditions of Contract (GCC) and the Particular Conditions of Contract (PCC).
- d) C-ESMP prepared in line with the ES requirements mentioned in this section

In general, the contractors are required to:

1. Follow all the instructions mentioned in this specification;
2. Prepare and submit ES Management Strategies and Implementation Plans (MSIPs) as mentioned in this specification;
3. Prepare and submit Contractor's Environmental and Social Management Plan (C-ESMP) as per the conditions of contract before mobilization of the work to be reviewed and cleared by the procuring entity;
4. Prepare ES monitoring plan to be included in the C-ESMP and monitor various environmental and social parameters mentioned in the monitoring plan.
5. Ensure availability of required contact information in the working site to handle any emergency situation during implementation of the work;
6. Submit environmental and social compliance report as mentioned in this section;
7. Appoint adequate number of dedicated Environment, Social, Health and Safety staff as mentioned in the Proposal Data Sheet (PDS) of the proposal document;
8. Provide training to its workers for smooth implementation of ESMP;
9. Submit code of conduct for contractor's personnel (including subcontractors as relevant), as per the form included in RFP document;
10. Ensure that the quoted rates adequately cover all aspects of this ES specification.

In addition to the provisions of Particular Conditions of Contract (PCC), the contractor needs to comply with the following additional requirements to relevant PCC clauses :

2.2. Clause 4.1 – Contractor's General Obligations

Without limiting the obligations under Sub-Clause 4.1 of the GCC/PCC, the Contractor shall:

1. Implement a risk-based approach to environmental and social management, commensurate with the excavation-intensive and traffic-sensitive nature of DMA and water supply system works;
2. Prepare segment-specific method statements for each DMA/water supply system in road section, covering excavation methodology, trench support, traffic management, pedestrian safety, utility coordination, and reinstatement;

3. Establish and operate a Permit-to-Excavate system, requiring verification of underground utilities, approval of trench support measures, and authorization by a competent person prior to excavation;
4. Maintain an Excavation and Urban Traffic Risk Register, updated regularly, documenting hazards, incidents, near misses, corrective actions, and lessons learned; and
5. Update (and if necessary prepare new plan as per the direction of the engineer in charge), submit, and obtain approval of the following Management Strategy and Implementation Plans submitted along with the bid which would combinedly form the Contractor's Environmental and Social Management Plan (C-ESMP) in accordance with the provisions of this specification prior to mobilization of works.
 - I. Traffic Management Plan (TMP);
 - II. Community Health & Safety Plan (CHSP) including trench safety, barriers, night safety, and emergency response;
 - III. Occupational Health & Safety Plan (OHS Plan);
 - IV. Waste and Spoil Management Plan;
 - V. Hazardous materials & fuel/oil management;
 - VI. Utility strike prevention plan (survey, permits, trial pits, coordination protocol, rapid restoration);
 - VII. Sexual Exploitation and Abuse (SEA) prevention and response action plan; and
 - VIII. Air quality management plan.

The C-ESMP shall be treated as a living document and updated as required, subject to approval of the Project Manager/Engineer.

2.3. Clause 4.6 – Co-operation

The Contractor shall cooperate fully with the Employer, PIU/PMU, Project Manager/Engineer, supervision consultants, utility agencies, traffic police, and local authorities to ensure effective implementation of ES requirements, including coordination related to:

- a) Traffic diversions and road occupation;
- b) Utility shutdowns, protection, and emergency restoration; and
- c) Community notifications and grievance resolution.

2.4. Clause 4.8 – Health and Safety Obligations

The Contractor shall prepare and implement a Health and Safety Management Plan specific to the Works, Sites, and all locations where excavation and construction activities are undertaken.

2.4.1 Occupational Health and Safety (OHS)

The Contractor shall apply the Hierarchy of Controls (elimination/substitution, engineering controls, administrative controls, and PPE) in managing excavation and other construction related works' hazards.

The following minimum requirements shall apply to all excavation and trenching activities:

- a. No excavation shall commence without an approved method statement, Permit-to-Excavate, and confirmation of underground utilities;
- b. Trenches 1.2 m or deeper shall be provided with safe access and egress (ladders, ramps, or stairs);
- c. Trench stability shall be ensured through appropriate shoring, benching, sloping, or shielding, considering soil conditions, groundwater level, and adjacent traffic loads;
- d. A competent person shall conduct and document daily inspections of trenches for signs of collapse, water ingress, or instability;

- e. Vehicles, rollers, and heavy equipment shall be kept away from trench edges to avoid surcharge loading;
 - f. Excavated materials: Excavated materials/equipment that could pose a hazard by falling or rolling into excavations should be kept at least 1 meter from the edge;
 - g. Dust: Dust should be kept to a minimum by spraying water or other means;
 - h. Plan safety into the job by considering Traffic, soil, water table;
 - i. Conduct daily inspections for possible cave-ins;
 - j. Don't start excavation before identifying and preventing risk of underground services
 - k. Use safe digging practice – use only hand digging with insulated tools for digging. Where electricity cables are detected, do not use mechanical or hand-held power tools within 0.5 meter of it;
 - l. Remove any spoil or excavated materials from the site immediate after the works.
- a)

Fall from height:

- a. Avoid work at height if feasible, e.g., using prefabricating wall frames, or using paint rollers with extendable handles rather than working on a ladder, etc.;
- b. Choose the right access equipment for work at height (e.g., using mobile elevated work platform instead of a ladder);
- c. Provide edge protection such as using guard-rails and toe boards at open sides;
- d. Install safety canopy or safety nets strong enough to retain individuals; and
- e. Provided workers personal fall arrest systems such as a harness with a short work restraint lanyard properly secured to a suitable anchorage point may be used.

Slips and trips:

- a. Ensure that all workers are provided with obstruction-free access and egress to their working areas;
- b. Keep work and storage areas tidy and designate specific areas for waste collection;
- c. Clean up all slippages immediately;
- d. Signpost all slippery areas and providing sufficient illumination at the workplace;
- e. Provide employees training, instruction and supervision for relevant work activities; and
- f. Use PPEs such as lifting straps, shoulder harness, slip resistant footwear to prevent slips, falls.

Vibration:

- a. Select alternate way of doing the job (e.g., use a hydraulic breaker to break a concrete beam instead of using hand-held breakers);
- b. Maintain equipment so that it is properly balanced, has no loose or worn-out parts and blades/cutters are sharp etc.;
- c. Use the power tool and attachment which will do the job properly in the shortest time; and
- d. Provide workers with PPE such as vibration protecting gloves.

Heavy Equipment: (Heavy Equipment includes but is not limited to: Mixer Machine, Soil Compactor, Steel Wheeled Road Roller, Drop hammer type Rigs, Steel Shutter)

- a. Operators should have: license, training, qualifications, certifications and medical fitness; and
- b. Safeguard and Control Measures

- Heavy Equipment should be equipped with: back-up alarm, horn and seat belt.
- All Motorized Heavy Equipment should require Rollover Protective Structures (ROPS) with seat restraints.
- Inspections Before use
- Traffic Management Plan (TMP): TMP should be developed for project/ site to ensure safe interactions between work activities, equipment, people and environment.

Material Handling: Safeguard and Control Measures for Loading and Unloading Hazards are:

- a. Use of mechanical lifting equipment e.g., Cranes, Forklifts and slings; and
- b. Safe Work zone during loading/ unloading, inspection.

Hot Work – Welding, Brazing and Cutting: Safeguard and Control Measures include but not limited to:

- a. Fire prevention: Remove all combustible materials from the area;
- b. Fire protection: Establish fire watch and install Fire extinguisher;
- c. PPE: Use appropriate PPE
- d. Skin protection: use fire resistant apron/ jacket and gloves, leather safety boots; welding helmet;
- e. Eye protection: Use welding helmet with UV protected shades and face shields for grinding; and
- f. Respiratory protection: Use filter respirators in ventilated areas and supplied air respirators (SARs) in confined spaces.

Electrical Safety Safeguard and Control Measures include but not limited to:

- a. Insulation - insulate electrical conductors with glass, rubber or plastic;
- b. Electrical protective devices - interrupts current flow when it exceeds conductor capacity like fuses, circuit breakers & ground fault circuit interrupters (GFCI's);
- c. Only competent persons who are trained and qualified to work on electrical equipment; and
- d. PPE for electrical work includes: Hard hat, Safety glasses, Long sleeve cotton shirt and long non-melting pants

Safety measures associated with the handling and use of bitumen (during the construction works of reinstatement of roads after trenching/excavation):

- a. Most significant hazard in the use of bituminous binders is exposure to elevated temperature which is often handled at temperatures above 130°C;
- b. Plant, equipment and processes should be planned to minimize the likelihood of personal contact with hot bitumen;
- c. Always carry out bitumen operations at low temperature;
- d. Good personal hygiene in respect of hands and inner clothing must be maintained;
- e. PPE like face shield, suitable eye protection (goggles), hand protecting Heat-resistant/chemical resistant gloves to be used. For foot protection heat-resistant heavy duty safety boots to be used, under no circumstances light shoes or sandals to be worn;
- f. Emergency response planning - bitumen burns:
 - Burns to the skin or eyes should be cooled immediately by drenching the burned area of the body under clean cold, preferably running water;
 - Emergency water showers with a minimum flow of 75 liters a minute at 2.1 bar should be delivered for a minimum of 15 minutes. Eye bath facilities should be available in close proximity to the working site;

- First-aid workers must be specifically trained for this bitumen accident purpose; and
 - An adequate number of approved bitumen burns first aid kits should be provided.
- g. Disposal of bituminous waste: Waste derived from bituminous binder applications to be disposed of at approved waste disposal sites. Bituminous binder waste includes spills, scrapings, flushing residue, contaminated product and bituminous mixtures.
- h. Precautions during heating of Bitumen;
 - Do not leave the tanker unattended when burners are on;
 - Discharge product from the tanker only when the burners have been turned off;
 - Do not stand directly behind burners when lighting or adjusting; and
 - Do not smoke or use cell phones during the heating operation.
- i. Transportation of hot bitumen:
 - Tankers must not be offloaded during heating;
 - During loading no source of ignition should be allowed in the vicinity of the receiving tank;
 - Earthing the vehicle to eliminate the accumulation of electrostatic charge is necessary during the loading or offloading of cutback bitumen; and
 - At least 10% space should be left after loading to allow for expansion resulting from any subsequent heating.

Community health and safety (CHS) Requirements:

- a. Provide adequate warning/safety signage at all sites visible to public;
- b. Provision of safe pedestrian access, including protected walkways, ramps, or trench covers to maintain access to residences, shops, schools, mosques, and emergency services;
- c. Prohibition of leaving open trenches unattended without adequate protection during non-working hours;
- d. Additional safety measures near sensitive receptors (schools, hospitals, markets), including timing restrictions and enhanced supervision; and
- e. Measures to prevent water stagnation in trenches and associated public health risks.
- f. Provide protective fencing surrounding the workplace area including internal fencing of storage areas and school activities in all sites as appropriate;
- g. Ensure that no nearby structure/installation is damaged/affected due to excavation, piling or any construction related activities;
- h. Contractor's activities and movement of staff will be restricted to designated construction areas;
- i. Location of batching plants and brick breaking machine if required, shall be located at least 100m away from the nearest community preferably in the downwind direction;
- j. No open place shall be used as a toilet facility;
- k. Faster trenching is preferable for better progress; and
- l. Prepare traffic management plan as applicable in accordance with the guidelines mentioned in this specification.

2.4.2 Traffic Management

The Contractor shall prepare and implement a site-specific Traffic Management Plan (TMP) for each DMA/road segment water supply system works prior to commencement of construction. The TMP shall include:

- a. Phased excavation and lane closure strategy to minimize congestion;
- b. Establishing diversion roads during the construction;
- c. Place traffic sign/cautionary sign to avoid undue traffic congestion;

- d. Deployment of trained flagmen with appropriate PPE and night-time visibility equipment;
- e. For regulation of traffic, the flagmen shall be equipped with red and green flags and illuminating vest at night especially near at intersection; and
- f. At night, the passage shall be delineated with lanterns/ suitable light source;
- g. Advance warning signage, speed control measures, and delineation of work zones;
- h. Efficient schedule of works considering the traffic movement at peak time;
- i. Safe pedestrian crossings and temporary access arrangements; and
- j. Emergency vehicle access at all times.

2.5. Clause 4.18: Protection of Environment

For protection of environment, the contractor would take appropriate mitigation measures to control air, water, noise pollution as per the national Acts/Rules/Standards. In case of non-availability of such standards, the GIIP is to be followed. Additionally, the contractor shall take necessary measures to offset the trees required to cut or enhance ecological conditions in the subproject areas by planting trees in the school premises and along the access road to the shelters, and no water bodies will be filled-up due to the construction of the flood shelters. Grass turfs will be placed on embankment, slope, building compound, and any critical places to enhance ecological conditions and protect the topsoil.

Contractor shall submit a contractor's environmental and social management plan (C-ESMP) to the PIU to review and for final concurrence which is to be followed rigorously across the sites under this work package. This C-ESMP will articulate all the measures relevant to the protection and conservation of Environmental parameters, prevention of pollution and management of resources, etc. Threshold values of different pollutants for environmental conservation and pollution control measures are set in the Environmental Conservation Rules, 2023 of GOB.

2.6. Construction and operation of labor shed for the workers (Workforce and labor shed management):

- The labour shed should be structurally safe with proper ventilation and should have proper sleeping provision on raised platform for the workers;
- Construction of sanitary latrine at the labor shed (consider one toilet for 15 person, and separate toilet for male and female);
- Ensure provision of waste bins (separate waste bins for organic and inorganic wastes; and
- Ensure proper disposal of the wastes (solid wastes and other forms of the waste) at the PWD/PMU recommended place and or City Corporation dumping ground.

2.7. Management and Safety of Hazardous Materials

Contractor will avoid or minimize community exposure to hazardous materials and substances that may be released by the project activities, material sourcing, project-related traffic and road safety risks, hazard due to use of construction equipment, construction debris handling and disposal etc. Contractor will ensure effective measures in place to address emergency events. Ensure that safeguarding of personnel and property is carried out in a manner that avoids or minimizes risks to the project affected communities.

2.8. Resource Efficiency and Pollution Prevention and Management

For Resource Efficiency, the contractor will identify feasible measures for efficient use of resources through:

- Use of energy;

- Water usage and management to minimize water usage during construction, conservation measures to offset total construction water demand and maintain balance for demand of water resources;
- Use of raw materials by exploring use of local materials, recycled aggregates, use of innovative technology so as to minimize project's foot prints on finite natural resources; and
- The Contractor shall ensure that emissions, surface discharges, effluent and any other pollutants from the Contractor's activities shall not exceed the values stipulated by national laws and regulations or GIIP in case of unavailability of national standard.

2.8.1. Control of Air Pollution:

Air pollution may occur during preparation of sites, earth excavation, subgrade preparation, stock yards and labour shed construction, grading and movement of vehicles, and the mitigation measures to be undertaken are:

- Regular watering and sprinkling during site preparation, excavation and construction of shelters, camp preparation, on stockpile of bare soil, haul road, un-surfaced traffic area and any sources of fatigue dust, when conditions require dust suppression;
- Ensure that all vehicles and machines comply with technical and environmental safety regulations;
- Schedule the operation times for vehicles, machines and equipment working in the construction area to reduce air emissions;
- Stockpiles of dusty materials will be covered by tarpaulin or similar materials;
- Speed of vehicles on site and in the approach road will be limited to 15-20 km/hr;
- Maintain adequate moisture content of soil and sand during transportation, compaction and handling;
- Carry sand and other construction materials with adequate cover; and
- Regular maintenance of the concrete mixer and vibrator machine to avoid any black smoke emission.

2.8.2. Control of water pollution:

Surface and groundwater can be contaminated by prolonged dumping of moist excavated soil, sewage & wastewater from labour camp, and effluent disposal and the mitigation measures are suggested below:

- Excavated soil will not be kept for prolonged period to avoid leaching;
- Waste disposal to be prohibited to waterbodies, arrange reuse/recycle;
- Labour camp should be constructed at a safer distance from the waterbody with septic tanks and soak wells;
- Arrangement of mobile toilets may be set at work sites if necessary;
- Fuel, oil and used oil storage areas shall be contained in concrete floor;
- Drain outlet should be regularly cleaned; and
- Proper storage area will be proposed with lining to avoid leakage.

2.8.3. Control of Soil Pollution:

Project site soil and sediment can be polluted due to disposal of solid and liquid waste of construction works, operation of heavy equipment, excavation activities, oil spillage of construction vehicles, bitumen discharge etc. Mitigation measures to be undertaken are:

- Construction vehicles will remain on compacted gravel/paved roads;
- Fuel, lubricating oil, and used oil storage areas will be in the designated area;
- Contractor shall ensure daily collection and disposal of construction waste, debris, oil, fuel spillage, used oil etc.;
- Covering the road shoulders and slopes by the first growing turf; and

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- To avoid bitumin spillage it should be suitably insulated during transportation and application.
- b)

2.8.4. Control of Noise Pollution:

Noise pollution may occur because of: Operation of vehicles and equipment during the site preparation, earth work, piling, stack yards and labour shed construction, transportation of construction materials, and mitigation measures are suggested below:

- Ensure the construction equipment are with proper silencer and muffler, padding/noise isolator and select the least noisy machine;
- Construction activities in day time and minimize night time working;
- Regulate the speed for traffic in and around the project areas;
- Regularly carry out maintenance and routine inspections on vehicles and construction machineries to ensure the technical standards;
- The personnel involved in high noise generating activities shall be provided with personal protective devices like ear plug, earmuffs etc.;
- Avoid using of rod cutter and welding machine at night;
- Avoid prolonged exposure to noise (produced by equipment) by workers; and
- Avoid operation of the concrete mixer and vibrator machine at night.

2.8.5 Management of Hazardous and non-hazardous waste

The Project will generate both solid non-hazardous and hazardous wastes throughout the construction phase. The anticipated non-hazardous waste types include excavated material, broken aggregates, municipal solid waste, concrete from broken piles, wastewater etc. While hazardous waste may include used oil, empty drums or replaced parts of the construction machinery, used battery, road marking paint etc. Mitigation Measures are given below:

- The hazardous waste/e-waste to be collected in steel drums and stored in a segregated roofed area and periodically disposed at approved waste disposal facilities;
- The camp site shall have compost pits for treating organic waste and separate bins for collecting the inorganic waste, which shall be disposed at nearest disposal sites; and
- The contractor shall at all times maintain his camp and construction sites in clean and tidy conditions and shall provide appropriate and adequate facilities for temporary dumping of all types of wastes before their proper disposal.

2.8.6 Ecosystem and Biodiversity

Negative Impacts on Eco-system and Biodiversity (Aquatic & Terrestrial Ecology) may occur because of spillage or disposal of solid & liquid wastes from onsite construction activities and vehicles & equipment may disturb the habitat of fishes. Mitigation measures suggested are:

- Activities near natural habitat should be avoided;
- No waste should be dumped in water bodies without proper treatment. Wastewater from camps & construction sites should not be disposed off in the waterbodies;
- No Storage of raw material, diesel, paint etc near waterbodies;
- No tree cutting even if any tree is to be cut, then plantation should be undertaken in minimum ratio of 1:3; and
- The Contractor shall take all reasonable precautions when transporting and using raw materials such as soil, aggregates, or plant material to prevent induction of invasive alien species.

2.9. De-Commissioning of Work:

- Contractor to remove labor camp at the completion of contract which may pose risk of exposure to dust, generation of liquid and solid waste, noise, vibration for which

adequate mitigation measures have to be undertaken for such contexts mentioned in earlier different sections;

- Besides, specially trained persons to be employed to remove potentially hazardous materials from the campsite like insulations or structural elements containing asbestos, electrical components etc.; and
- The concrete and asphalt plant or heavy machineries installed during construction should be dismantled during de-commissioning without causing any harm to the environment & local community and the area to be cleared off from any debris or residual concrete/bituminous or other substances.

2.10. Security of the Site

Contractor to provide security to safeguard its personnel and property, with employing sufficient number of security personnel at site and offices. The Contractor shall (i) conduct appropriate background checks on any personnel retained to provide security; (ii) train the security personnel adequately (or determine that they are properly trained) in the use of force (and where applicable, firearms), and appropriate conduct towards Contractor's Personnel, PIU personnel, and affected communities; and (iii) require the security personnel to act within the applicable Laws.

The Contractor shall not permit any use of force by security personnel in providing security except when used for preventive and defensive purposes in proportion to the nature and extent of the threat as per applicable national law.

2.11. Archeological and Geological Findings

Contractor shall protect archeological/cultural or built heritage, whether tangible or intangible and irrespective of legally recognized or protected, from the adverse impacts of project activities that are linked to excavations, demolitions, piling, vibrations from heavy machinery, or other physical changes including air or water pollution or changes in water level, and support its preservation, primarily through the identification of such findings in E&S screening documents or consultation with the people in surrounding areas and national or subnational cultural heritage authorities, assess the risks and impacts from the project activities, and put actions to avoid, mitigate, and/or manage them. Such actions may include halting construction activities, protection of heritage in its place, limiting visitations, or community-sanctioned movement around the place, etc. and it is important that any protective or conservative measures must coincide with national laws and involve relevant authorities.

'Chance finds Procedure' shall be adopted by the contractor if previously unknown cultural/archeological heritage or geological footprint is encountered during project activities, which may include, but not limited to, a single artifact, an artifact indicating the presence of a buried archaeological site, human remains, fossilized plant or animal remains or animal tracks, or a natural object or soil feature that appears to indicate the presence of archaeological materials, rock/sediment strata containing undefined object, fissures of gases, oil, etc. The procedure will include: (i) a requirement to notify relevant authorities of found objects or sites, ((ii) to fence-off the area of finds or sites to avoid further disturbance, (iii) to conduct an assessment of found objects or sites by the relevant authority, (iv) to help identify and implement actions consistent with the requirements of national law, and (v) to train project personnel and project workers on chance find procedures.

2.12. Rate of Wages and Conditions of Labor

The Contractor shall:

- Provide written agreement of contract to workers and payment slip;
- Ensure discrimination on employment and payment of wages are avoided;
- Pay wages as per current Labor Law and Government regulation;
- Keep records of hours worked, remuneration and deductions (including overtime), collective bargaining agreements;
- Record incidents and corresponding Root Cause Analysis (lost time incidents, medical treatment cases), first aid cases, high potential near misses, and remedial and preventive

- activities required (for example, revised job safety analysis, new or different equipment, skills training, and so forth);
- Ensure safe and healthy work and living conditions including maintaining of protocols in case of any pandemic;
 - Establish a GRM to raise worker grievances; and
 - Use of Child labor is strictly prohibited.

Clause 6.27: Training of Contractor's Personnel and Code of Conduct (CoC)

Contractor shall brief the workers about health, hygiene, and safety protocols, and overall ES management regularly, and also conduct training program for raising awareness and knowledge on ES issues. The Contractor shall also actively engage the Contractor's Personnel in promoting understanding, and methods for, implementation of health and safety requirements, as well as in providing information to Contractor's Personnel, and provision of personal protective equipment without expense to the Contractor's Personnel.

The Contractor will also undertake awareness building programs for the workers to prevent sexual exploitation & abuse (SEA) and sexual harassment (SH), and shall regularly consult with the workers both male and female and brief them about behavioural matter to avoid any SEA and SH. and minimization of the sexually transmitted diseases (STDs) and communicable diseases.

The contractor is to arrange training for the workers on the following issues:

- a. GBV/SEA/SH (Gender Based Violence/Sexual Exploitation and Abuse/ Sexual Harassment, Code of Conduct);
- b. Health and hygiene;
- c. Occupational Health and Safety.
- d. Community Health and Safety.
- e. Awareness training about the communicable diseases like STDs, HIV/AIDS etc.;
- f. Efficient use of resources and prevention of pollution.
- g. Standard operating procedures (SOP) for construction and bituminous works;
- h. Emergency Procedure and Response; and
- i. Waste Management

Contractor will also indicate the duration, frequency and timing of these training. The details of the training to be provided shall be documented and made available to the PIU for monitoring.

2.13. ES Monitoring:

The purpose of ES monitoring is to verify effective and timely implementation of mitigation measures specified in the C-ESMP. The following matrix includes indicative parameters to be monitored. However, the contractor would prepare ES monitoring matrix as part of their C-ESMP following but not limited to this matrix and finalize it as per the direction of the engineer in charge. This monitoring will generally be carried out by Supervision Consultant, the Environmental, Social and OHS specialist to be recruited by the contractor and safeguard focal point of CWASA with the help of checklists (will be prepared and included in the C-ESMP) to be prepared on the basis of the mitigation measures. It is to be noted that monitoring will be carried out for all sites under this subproject as applicable.

Daily site diaries, weekly ESHS summaries, and monthly ES monitoring reports shall be submitted to the Engineer. The purpose of the compliance monitoring is to ensure that the contractor implements the mitigation measures mentioned in the C-ESMP effectively and timely.

Table: Environmental and Social Compliance Monitoring

Monitored Parameter/ Issues	Monitoring Method/ Key Aspects	Location of Monitoring	Frequency of Monitoring and Reporting	Responsible
Safety orientation and training of workers	Frequency of training & orientation of workers for safety	All subproject sites	Monitoring: once in a month; Reporting: once in a month	Contractor Monitoring-Primarily by Supervision Consultant Secondarily by Project Management Unit (PMU), CWSIP
Barricading & lighting	Integrity and visibility	Work front perimeter	Daily (day & night)	
Traffic signage & flagmen	Compliance with TMP	Intersections /approaches	Daily	
Use of Personal Protective Equipment (PPE)	Ensure every single person involved in the activities wear and use PPE	All subproject sites	Monitoring: daily; Reporting: once in a month	
Worker's health	Monitoring process of worker's health	All subproject sites	Monitoring: daily; Reporting: once in a month	
Sanitation & drinking water facility to the workers	Availability of safe drinking water and sanitation to the workers	All subproject sites and work site	Monitoring: daily; Reporting: once in a month	
Incident record and reporting	Documented record of all incident, accident, its remedial process	All subproject sites	Monitoring: daily; Reporting: within 48 hours	
Bulletin/ announcement boards/ prohibition signs	Visible in good condition or not	All subproject sites	Monitoring: daily; Reporting: once in a month	
Dust	Dust is visible or not	All subproject sites	Monitoring: daily; Reporting: once in a month	
Noise	Using portable noise detector	All subproject sites	Monitoring: daily; Reporting: once in a month	
Child labor	No child will be engaged in the activities	All subproject sites	Monitoring: daily; Reporting: once in a month	
Handling of hazardous materials	Fueling, storage, operation	All subproject sites	Monitoring: daily; Reporting: once in a month	

2.8. Compliance and Enforcement

Failure to comply with these ES Requirements shall constitute non-compliance with the Contract and may result in corrective actions, suspension of works, withholding of payments, or other remedies as provided under the GCC/PCC.

SPECIFIED PROVISIONAL SUMS FOR ES OUTCOMES

The total of the prices of the activities in the Activity Schedule is the Proposer's offer to complete the works on a "single responsibility" basis. This includes all of the Contractor's ES obligations under the Contract.

Provisional sums may be specified by the Employer for achieving specific ES outcomes. (e.g. for HIV counselling service, and SEA awareness and sensitization or to encourage the contractor to deliver ES outcomes beyond the requirement of the Contract).

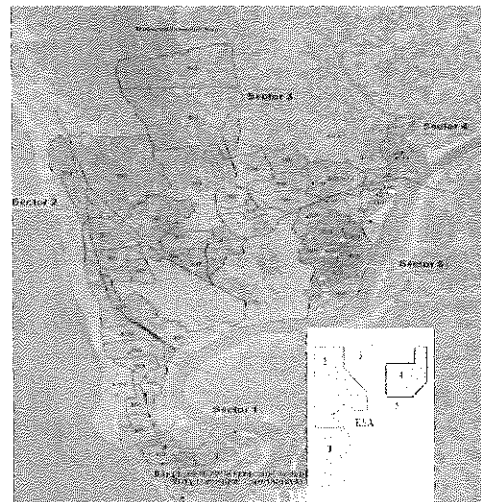


L2-2 SCOPE OF THE WORKS

L2-2.1 Overview of the project

The Chattogram Water Supply Improvement Project has been undertaken to address the growing water supply challenges in Chattogram City, which is experiencing rapid population growth and urban expansion. To meet these demands, the Chattogram Water Supply and Sewerage Authority (CWASA) has launched various investment initiatives, including World Bank-financed CWSISP and JICA-supported Karnaphuli Water Supply Project (KWSP) Phases 1 & 2.

The KWSP projects address the water demand of the Karnaphuli Supply Area (KSA), encompassing the traditional and historical core of Chattogram, which predates the city's rapid expansion over the past four decades. In addition to the KSA, CWASA is committed to enhancing water supply services in the surrounding areas, which, based on previous studies, have been divided into five sectors. These sectors, collectively referred to as the Project Area, integrate infrastructure developed under the CWSISP and are strategically. Relative positioning of sectors in the map and graphs are shown in right.



The present study builds upon these efforts by focusing on extending 24/7 sustainable water supply to five sectors, incorporating smart District Metering Areas (DMAs) to improve monitoring and efficiency. This initiative aligns with Sustainable Development Goal (SDG) 6: ensuring access to clean water and sanitation for all by 2030.

Investments under this package are planned for meeting demands in 2032. With no investment into new surface water treatment plants, the supply of drinking water in the service area in 2032 will be constrained by the output capacities of the existing water treatment plants, with supplementary interim supplies from NRW reduction and the possible expansion of existing water sources, pending the robust long term source development plans to be developed in the upcoming Water Supply Master Plan. Water available all possible sources would be 260 MLD if ground water treatment can be reinstated at Kalurghat to make 40 MLD as maximum. Only 40 MLD of an estimated potential 83 MLD (286-203MLD) of unused capacity was taken into account, given CWASA's concern regarding achievable demand reduction in the KSA. Both Mohara and Modunaghat plants continue to produce 90 MLD from each.

Then 2032 investments were planned focusing following be well within the available water supply of 260 MLD.

1. NRW reduction
2. satisfactory service for existing customers
3. new service connections.

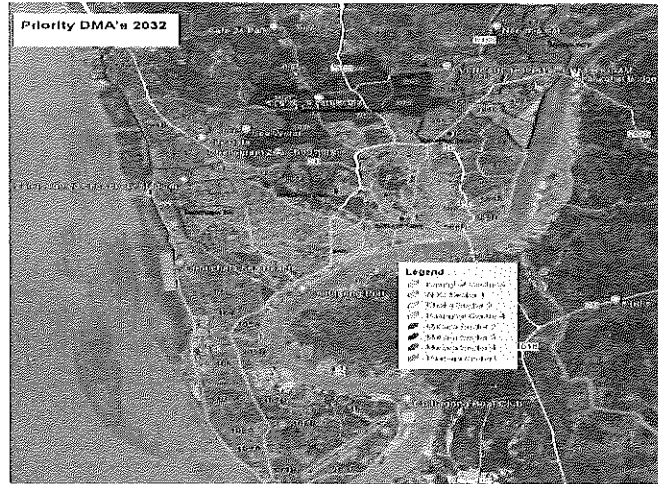
DMAs were selected targeting such a way that total demand equal to 258 MLD as shown in Table 2-1

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Table 2-1 : Estimated Demand of selected DMAs for Investments

Sector	Demand 2032 (excluding NRW)	NRW	Total requirement (including NRW)	Total requirement in selected areas (including NRW)
1	79	20%	99	77
2	116	20%	145	64
3	56	20%	70	18
4	56	20%	70	43
5	45	20%	56	56
Sub total	352		440	258
KSA	183	10%	203	203
Total	535		643	461

Figure 2-1: Selected DMAs



To streamline implementation, all Smart DMA establishment, NRW reduction, pipe replacement, and system reinforcement activities are distributed across two lots of this package (Package CWSIP/W1):

□ **Lot 1- Covers Sectors 2 and 3, supplied by Mohara WTP system:**

The Mohara Water Treatment Plant (WTP) will supply:

- 18 MLD to Sector 3
- 64 MLD to Sector 2
- 6 MLD to DMA 401A in sector 4

This utilizes its full production capacity. Additionally, a proposed 53 MLD DT booster station will supply most of Sector 2 by receiving water from the primary Mohara main transmission pipeline. The remainder will either be supplied directly through the main pipeline or pressure-boosted at the proposed Khulshi pumping station.

□ **Lot 2 - Covers Sectors 1, 4, and 5, supplied by the Modunaghat WTP and Kalurghat IRP System:**

A total of 90 MLD will be transferred to the Kalurghat Clear Water Tank (CWT) in addition to production of 80 MLD from the Kalurghat Iron Removal Plant (IRP)). This total 170 MLD supply enables water distribution to:

- Sector 4 (excluding DMA 401A, which uses 6 MLD): 39 MLD
- Sector 5: 56 MLD

Additionally, 75 MLD will be pumped to the rehabilitated ADC Hill reservoir, enabling:

- Gravity-fed supply to the northern part of Sector 1
- Boosted supply to the southern part via the Patenga pumping station

The layout is schematically represented in Drawing, which also indicates sector metering locations. Sector meter readings will be compared with downstream DMA meter readings, while DMA readings will be further validated against customer meter readings. It is proposed

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to use electromagnetic meters for both sector and DMA meters, while AMR (Automatic Meter Reading) meters, either electromagnetic or ultrasonic, will be used for all customer connections.

The implementation of the metering system, along with integrating stand-alone SCADA systems for each area, will be addressed under Package CWSIP/G3.

L2-2.2 Scope of Works -Lot 2

This Section describes of the Scope of Works for this Lot 2 Contract and shall be read in conjunction with the Bill of Quantities, specification and indicative drawings. This Scope covers the design, construction, commissioning and trial operation of Works to achieve a level of NRW for the entire system downstream of Modunaghat WTP and Kalurghat IRP raw water inlet not exceeding 10% (ten percent) while maintaining a continuous supply of water to every registered CWASA customer at a pressure not less than 1.0 bar at the inlet of the customer meter, as described herein and shown in the Drawings, including all necessary investigations, surveys, designs, procurements, installations, performance tests, system commissioning, flow measurements, leak repairs, leak surveys, leak locations and liaison with CWASA for the provision of new registered connections to prospective customers and LICs for the duration of the Services. The Works described in detail in sub-sections L2-2.1 to L2-2.5 below comprise, *inter alia*:

- 35.1 Km of new pipes to replace degraded existing transmission and distribution pipes and fittings with appropriately sized HDPE and DI pipe and their associated fittings;
- 156.1 Km of new HDPE and DI pipe and associated fittings to reinforce and extend the existing transmission and distribution networks;
- Approximately 19500 new service connection pipes to replace those of CWASA's registered customers and provide connections to new CWASA customers, all from the nearest distribution pipe to the inlet of the customer's meter;
- Establishment of an estimated 28 Smart DMAs in Sectors 1, 4 and 5 to be used by Contractor in the first instance to reduce the NRW within each and every Sector to below 10% using DMA flow measurements, step tests, leak detection surveys, leak repairs, unregistered service pipe surveys and such other means as CWASA agrees, and Contractor is disposed, to deploy;
- Reconfiguration, refurbishment and improvement of the existing Kalurghat IRP to treat 40 MLD of deep tube well (DTW) water for supply to the existing Kalurghat ground level reservoir, with all necessary connecting pipework and the decommissioning, demolition, disposal and backfilling of the existing aeration towers and sedimentation basins;
- A new pump station next to the existing Kalurghat Booster Station equipped with independent sets of pumps to transmit treated water from the Kalurghat ground level reservoir to Sectors 4 and 5;
- Rehabilitation of the existing ADC Hill service reservoir, site and perimeter walls and fences with additional and replacement connecting pipework and control valves such that it receives treated water from the existing Kalurghat booster pumps and provides balancing storage and a gravity supply to the Northern part of Sector 1 and to the Patenga Booster station for onward transmission to the Southern part of Sector 1;
- 15 in-line booster pumps to pressurise the distribution networks in elevated areas. The maximum capacity of such pump can be taken as 5 KW for estimation purposes.
- A Pump Station near Chittagong Urea Fertilizer Comapany Area to Convey 30 MLD water produced from Bhandaljuri Water Treatment Plant (BJWTP) to Sector 1 Area.

- Approximately 7 Km of new HDPE pipe and associated fittings to convey 30 MLD water produced from Chittagong Urea Fertilizer Company Area to Sector 1 Area through utility duct of Karnaphuli Tunnel.

L2-2.3 Work Section 1: Design and Construction of Transmission and Distribution Systems

L2-2.3.1 Hydraulic Network Design and Detailed Design of Pipe Network

The Contractor shall prepare detailed designs of the distribution system reinforcements, replacements for unfit existing distribution pipes and the DMAs to be established in the Lot 2 transmission and distribution system, based on the indicative drawings and the preliminary hydraulic model of the Employer. The scope of services for such designs shall include but shall not be limited to:

- (a) Update of the CWASA GIS with registered street names (Bangla and English equivalents), and unique street identification codes for un-named streets and alleyways with compilation of a table of Standardised Street Names for property and customer addresses and their equivalent historical and current abbreviations and nomenclature in CWASA's billing and network records;
- (b) Detailed Service Area investigations and updating of the existing transmission and distribution network GIS, to include permits, excavation, documentation and reinstatement of any and all trial holes required to verify valve and hydrant locations, pipe sizes, materials and connectivity. In addition the contractor would be responsible for recording and documenting the fluid flow performance baseline details at the start of the project.
- (c) Detailed topographical surveys (longitudinal elevation and plan) throughout all the necessary new pipe routes;
- (d) Comprehensive field surveys of all properties and street hydrants within connection distance of a CWASA distribution pipe to record the presence or absence of an existing service pipe associated with the property in the CWASA GIS, registered with CWASA or not, together with the address of the property, using the Standardised Street Name, the customer identifiers of existing CWASA customers from the CWASA billing database, and the precise location of the customer meter, or the observed position of an unmetered connection at its nearest point to the property curtilage, expressed as UTM coordinates and the applicable level 16 Uber H3 cell reference;
- (e) Obtain from Bangladesh Bureau of Statistics (BBS), incorporate into the CWASA GIS enumeration area boundaries and relevant population and household data from the 2022 census;
- (f) Use BBS enumeration area boundaries, level 9 or 10 Uber H3 hexagons or similar standardised spatial compartments to bring together the corresponding CWASA customer usage, BBS property, household and population data, Contractor's property survey results and verified network pipe details to update the hydraulic model junction demands to the present time for hydraulic model calibration;
- (g) Updating and calibration of CWASA's hydraulic model of the overall network to verify hydraulic sufficiency of Employer's preliminary designs, calibration to be

performed using CWASA's existing network of flow meters and pressure loggers installed concurrently for at least 24 hours at a minimum of 20 locations (but not less than a pressure logger for 2 km of pipeline) supplied from pipes of at least DN200 located at the extremities and main junctions of the extended network with the differences between measured and modelled flows not to exceed 10% of measured flow and the differences between measured and modelled piezometric head not to exceed 2.0m or 10% of the difference between measured head and the concurrent piezometric head at the source of supply, whichever, is the greater;

- (h) Combine the calibrated hydraulic model of the existing system with CWASA's most recent estimates of 2052 water demand and distribution network designs to create an updated hydraulic model of the planned 2052 water distribution system and CWASA customer base;
- (i) Review and update Employer's 2052 network designs according to the design criteria stipulated in section L2-5.2.1.
- (j) Review the Employer's 2032 network design and incorporate any changes to the components of Employer's 2052 network design retained for the corresponding 2032 network design, optimize the hydraulic design by considering energy saving as per design criteria stipulated in section L2-5.2.1.
- (k) Detailed site investigation for verification of suggested DMA boundaries, locating of existing boundary valves, functioning and tightness checks of existing boundary valves;
- (l) Check and optimise Employer's DMA designs using the updated 2052 hydraulic model;
- (m) Incorporate the final DMA designs into the 2052 and 2032 hydraulic models and use these to optimise pressure management:
 - a. stabilizing, managing and reducing average DMA pressure using pumps controllers and various techniques as appropriate;
 - b. ensure that the volume of water supplied to customers in the DMA is the same or better than the baseline levels at the start of the project;
 - c. verify the reservoir sizes with the revised hydraulic design;
- (n) Installation of any and all additional valves, end-caps and cross-connections required to fully isolate each and every DMA while ensuring all existing and potential CWASA customers within and around the DMA can be supplied at a pressure of at least 1.0 bar at the meter inlet in 2052;
- (o) Validation of each DMA boundary with a successful night-time zero-pressure isolation test, verified by the Construction Supervision Consultant;
- (p) Selection of the location for DMA inflow chamber(s) with cable and pipe location surveys and any and all test pits required to ensure that the space required for chamber construction is available and unobstructed;
- (q) Validation of DMA performance with a 7-day isolated supply test with all boundaries closed except for the pipe on which the DMA meter chamber will be constructed, to ensure that all existing and potential CWASA customers within and around the DMA



- can be supplied at a pressure of at least 1.0 bar at the customer meter inlet, verified by the Construction Supervision Consultant;
- (r) Construct, connect and prepare the DMA meter chamber and instrument pillar (if required) ready to receive the Smart DMA flow meter and the associated pressure and water quality monitoring, data recording and communication devices and notify Employer and the Construction Supervision Consultant of the DMA meter chamber readiness for installation of the meter and monitoring instrumentation namely parameters (temperature, pH, free chlorine, EC, TOC, and turbidity by the (CWSIP/G3) Smart Metering Contractor;
 - (s) Using the 2052 hydraulic model select and obtain Construction Supervision consultant approval for a location for a Critical Monitoring Point in each and every DMA where a reduction in supply pressure is most likely to result in local pressure falling below 1.0 bar;
 - (t) Construct and connect the Critical Monitoring Point instrument pillar to the corresponding distribution pipe and notify Employer and the Construction Supervision Consultant of its readiness for installation of the monitoring instrumentation by the CWSIP/G3 Smart Metering Contractor;
 - (u) Attendance in support of the CWSIP/G3 Smart Meter Contractor on the day(s) of Smart Meter and Critical Monitoring installation;
 - (v) Routine monitoring of the data from the DMA and Sector flow, pressure, water quality and customer usage values to prioritise leak detection and unregistered connection surveys,
 - (w) Report any unregistered connection to Employer and proceed as instructed by Employer to disconnect and remove unregistered connections;
 - (x) Detect and repair the backlog of unreported leaks remaining in the completed DMAs and any new leaks indicated by the DMA instrumentation;
 - (y) Register the impact of leak repairs and the elimination of unregistered connections on DMA and Sector NRW values and take all necessary measures to ensure that:
 - a. pressure at the Critical Monitoring Point remains above 1.0 bar at all times;
 - b. the difference between concurrent total inflow and aggregated customer usage falls to and remains below 10% of the recorded inflow until the end of the Maintenance Period;
 - (z) Detailed design includes but not limited to:
 - a. all pipelines to be laid as feeder mains or distribution pipes within DMAs including old AC and PVC pipe replacements, comprising culvert, river, railway and road crossings, thrust blocks, restrained pipe lengths and all junction detailing works;
 - b. all electromechanical works to be installed or modified;
 - c. all water storage facilities including rehabilitation works to existing reservoirs within the system;
 - d. all structures including pump station buildings complete with electrical rooms, control room etc;

- e. on-street booster pumps and inflow meter along with all the required pipework and structural elements and the location and design of the above-ground instrumentation boxes;
- f. sub-divisions within each DMA to carry out step tests and prepare all necessary drawings, proposed sectional valves and valve operation sequences;
- g. standard design and map with location of all customer connections to be relocated;

A detailed description of works of each major component is described hereafter based on preliminary analysis of the system. Information provided shall be considered in the detailed design.

L2-2.3.2 Supply and installation of pipelines

- (a) Laying of Ductile Iron Primary Distribution Mains of 1,200mm dia. of Minimum 2.0 km, 5.8 km of 1,000 mm dia., 4.8 km of 800mm dia., 2.2km of 600mm dia Supply Water to unserved Areas of the Sector - 1.
- (b) Ductile Iron Secondary Distribution Mains of 600mm diameters (Minimum 2.02km long) to Supply Water to unserved Areas of the Sector – 4.
- (c) Ductile Iron Primary Distribution Mains of 600mm diameter of Minimum 4km long to Supply Water to unserved Areas of the Sector – 5.
- (d) Supply & laying of Minimum 50.20km, 49.3km & 55.6km Distribution system within sector 1, 4 & 5 respectively.
- (e) Supply & Replacement of the defective / unserviceable Asbestos Cement (AC) / PVC Pipes, Fittings & Valves with HDPE Pipes, Fittings and Valves of approximately 7.3km, 3.3km and 6.43km long within the Sector 1, 4 & 5 Area respectively, including of replacement of 1.03km AC Pipes with 600mm diameter DI Pipes & Fittings, 1.0km AC / MS Pipes with 800mm diameter DI Pipes & Fittings in Sector 1, replacement of 1.9 km AC Pipes with 600mm diameter DI Pipes & Fittings in Sector 4.
- (f) Approximately 7 Km of new HDPE pipe and associated fittings to convey 30 MLD water produced from Chittagong Urea Fertilizer Company Area to Sector 1 Area through utility duct of Karnaphuli Tunnel.

The Contractor to consider the below tabulated details of Pipes for supply and installations as minimum requirements under this Contract, which shall also include the provision and installation of minimum 112 km of Minimum 90 mm outside diameter HDPE pipelines designated for infill distribution lines.

New & Reinforcement HDPE Pipes

Outer Diameter (mm)	Total Pipe Length (m)			
	Sector 1	Sector 4	Sector 5	Total for Lot 2
110	1,858	304	12,174	14,366
125			22	22
160	5,871	20,892	12,045	38,808
180	27,815	4,448	2,500	34,763
225	3,514	8,632	14,485	26,631

Outer Diameter (mm)	Total Pipe Length (m)			
	Sector 1	Sector 4	Sector 5	Total for Lot 2
280	662			662
315	6,274	6,442	5,726	18,442
355	2,000	3,881	3,191	9,072
400		2,549	3,216	5,765
500	2,188	2,146	1,971	6,305
560	17		261	278
	50,199.00	49,294.00	55,591.00	151,416.00
Replacement HDPE Pipes				
Outer Diameter (mm)	Total pipe Length (m)			
	Sector 1	Sector 4	Sector 5	Total for Lot 2
110			4,596	4,596
125				-
160			31	31
180				-
225			966	966
280				-
315				-
355	2,981		142	3,123
400				-
500	1,466	2,432	691	4,589
560	2,832	860		3,692
	7,279.00	3,292.00	6,426.00	12,735.00

L2-2.3.3 Sector Metering Points

Design and construction of Smart Sector Monitoring Stations to monitor sector inflows, pressures and water quality parameters from control valves (upstream and downstream pressure), transmission pipelines, pumping stations and service reservoirs, including all necessary pipework, valves, tapers, tees, fittings, chambers, instrument pillars, cable ducts and spool pieces, all ready to receive the flow meter, pressure transducers and water quality sensors, data loggers and communications equipment to be installed by the Package CWSIP/G3 Smart Metering Contractor following notification of Employer and the Construction Supervision Consultant, including attendance and support to the Smart Metering Contractor on the day(s) of meter and ancillary equipment installation.

L2-2.3.4 On street Booster Pumps

The Contractor shall identify low pressure areas in Sectors in his detail analysis and shall supply and install pumping systems accordingly. These systems shall be located in

underground chambers beneath access roads or in public land as depicted in drawing or alternatively provided as dry-installation-type submersible pump arrangements. As per the preliminary hydraulic analysis, the pump capacities are estimated to range from $Q = 8$ MLD, $H = 10$ m to $Q = 20$ MLD, $H = 45$ m, with approximately two pumps anticipated across the three sectors. The control panels shall be installed above ground in a weatherproof enclosure. Pumps shall generally be with VFD control. However, for smaller capacity pumps (less than 5 kW) soft starter and DOL starters are acceptable. Automatic operation shall be provided based on delivery set pressure and GSM network communication shall be provided for monitoring the pumps with SCADA installed in the upstream pump station. Monitoring instrumentation shall typically include pump status, power status and chamber flood alarm. A beacon light shall be provided on the control panel enclosure with contact telephone numbers of the maintenance party so as to get feedback from passers-by.

Protection against inlet low pressure shall be provided using an electromechanical pressure switch.

Delivery flow meter (Electromagnetic) shall be provided. Delivery flow meter readings are to be used by contractor for sector / DMA flow meters (third party) as well. Therefore, these readings shall be made available to the contractor for DMA / sector monitoring. Wall mounted enclosure (approximately 600 x 450mm) shall be provided under the scope of this contract with following interface,

- UPS power at 24V / 230V with breaker. (200Watts)
- Optically isolated pump delivery flow signals in 4-20mA format.
- Removable mounting plate for third party hardware installation.

Remote Actuation and Monitoring Panel shall be provided in each site for data transmission to respective pump station ICA / SCADA system for monitoring and parameter setting.

L2-2.3.5 Modifications to Modunaghat Transfer Pump Operation System

The Modunaghat transfer pumps are required to operate under very low / negative static pressure condition. Contractor shall eliminate the possibility of pump runout operation by introducing artificial back-pressure by throttling the delivery valve control as required, for example when only one or two pumps are in operation. It is also necessary to prevent the transmission pipeline draining into the Kalurghat ground level reservoir by coordinating the operation of the inlet valve to the Kalurghat ground level reservoir with the operations of the Modunaghat pumps by incorporating a mechanism for immediate closure of the Kalurghat ground level reservoir inlet valve when Modunaghat transfer pumps are stopped, whether intentionally or as the result of a local power failure, and reopening as the Modunaghat pumps resume operation. This might be achieved by the installation of a suitably dimensioned and controlled pilot-operated pressure sustaining valve (PSV) on the inlet pipe to the Kalurghat ground level reservoir, suitably damped to minimize pressure transients in the transmission pipeline.

L2-2.3.6 Modifications to Existing Kalurghat Pumps to Transfer Water to ADC Hill

The new pumping station at Kalurghat to supply Sectors 4 and 5 shall be designed and built by the Contractor and the pumps at the existing Kalurghat pump station shall be repurposed to supply treated water to Sector 1 via the ADC Hill reservoir, which the Contractor shall refurbish and adapt to serve as the Sector 1 balancing tank and gravity supply.

L2.2.3.6.1 SCADA System Modification

The Contractor shall upgrade or replace the existing Kalurghat pump station SCADA system to provide coordinated control of both the existing pumps and the necessary pressure sustaining inlet valve to the ADC Hill reservoir. The Contractor shall integrate this SCADA with the SCADA system for the operation of the new Sector 4 and 5 pumps and the inflows from the upgraded Kalurghat IRP and the Modunaghat transmission pipeline to ensure that the water level in the Kalurghat ground level reservoir is always sufficient to provide the NPSH required by the new and existing pumps but never reaches the level of the overflow weir.

Alternatively the Contractor may propose all new SCADA equipment combining all the sensors, communication equipment and controls needed to monitor and coordinate the operation of the entire supply chain system comprising the Modunaghat CWT, treated water pumps and transmission pipeline, the refurbished and upgraded Kalurghat IRP, the new Kalurghat pump station for Sectors 4 and 5, the existing Kalurghat pump station repurposed to supply the refurbished and upgraded ADC Hill Reservoir, the existing Kalurghat ground level reservoir and the Patenga ground level reservoir and booster pumping station.

This task is included in the scope of the contract and for tendering, the bidder may coordinate with client / local agent of the existing equipment for preparing price proposal.

L2.2.3.6.2 Yard Piping Modifications

The delivery pipeline of the existing Kalurghat distribution pumps shall be permanently connect to the existing 1200mm DI transmission pipeline in order to transfer water to ADC hill reservoir. The works includes supply and installation of isolation butterfly valve in 1200mm pipe as indicated in drawings.

L2-2.3.7 New Pump Station for Distribution Pumps for Both Sector 4 and 5

The new booster system at Kalurghat is to be designed and constructed to meet the average demands of 37 MLD and 56 MLD in Sectors 4 and 5 by 2032. However, the system shall be constructed to accommodate the capacity required by 2052. The PIP pumps and electrical switchgear will be supplied to support the 2032 capacity. Provisions will be incorporated in the design to accommodate the 2052 extended capacity by sizing suction, manifolds, and additional inlet pipes from a proposed new surface water treatment plant located within the premises.

The major components of the booster system shall include but not be limited to:

- (a) Suction header from existing ground reservoir;
- (b) A pump station and electrical buildings
- (c) Generator building;
- (d) 05 Nos. pumps in 3 duty + 2 Standby configuration for sector-4,
- (e) 04 Nos. pumps in 3 duty + 1 Standby configuration for sector-5
- (f) MV / 3.3kV transformer
- (g) 3.3kV / 0.4kV transformer
- (h) 3.3kV generator
- (i) MV switchgear
- (j) 3.3kV switchgear
- (k) VFD units for main pumps
- (l) Electrical panels MCC (Motor Control Centre) LOS (Local Operation Station), etc.

- (m) Instrument Control and Automation Panels (ICA), Remote Actuation and Monitoring Panels (RAMP)

L2.2.3.7.1 Pump Station and Electrical Building:

Pumps for 2032 Capacity: A minimum of 4 pumps shall be installed specifically for each Sectors, selected to meet the projected demand for 2032. Each pump set will be complete with control and instrumentation panels.

L2.2.3.7.2 Main Pumps Sector 4 and 5

Details of the main pumps to be installed for sector 4 & 5 are indicated in Table 2 below,

Table 2: Hour head variation chart for Sector 4

Pump Tag Nos.	20x-PP-01
Purpose	to pump clear water to distribution – Sector-4
Pump type	Horizontal, split casing double suction
Number	3 duty + 2 standbys
Rated capacity	833 m3 / hr each pump
Indicative head	45 M
Speed	Less than 1500 rpm
Minimum efficiency	85%
Flange Class	PN16
NPSHA	Approx. +10 m (at 120% point of Rated Capacity)
MOTOR	
Motor rating	122 kW, minimum.
Motor enclosure. protection	IP 55
Converter operation	Required
Insulation class	Class-F
Temperature rise	Not to exceed that of Class-B, with VFD operation at full load.
Voltage	3.3kV

Table 3: Hour head variation chart for Sector 5

Pump Tag Nos.	20x-PP-01
Purpose	to pump clear water to distribution – Sector-4
Pump type	Horizontal, split casing double suction

4

Number	3 duty + standby
Rated capacity	1250 m ³ / hr each pump
Indicative head	40 M
Speed	Less than 1500 rpm
Minimum efficiency	85%
Flange Class	PN16
NPSHA	Approx. +10 m (at 120% point of Rated Capacity)
MOTOR	
Motor rating	160 kW, minimum.
Motor enclosure protection	IP 55
Converter operation	Required
Insulation class	Class-F
Temperature rise	Not to exceed that of Class-B, with VFD operation at full load.
Voltage	3.3kV

L2.2.3.7.3 Existing Pumps

There are 6 Nos. existing pumps, presently used for direct distribution. They will be used to pump water to ADC reservoir. The pumps are fixed speed and the flow control will be by changing the number of operating pumps.

L2.2.3.7.4 Penstocks, Valves and Actuators

Table 3 gives the actuator operated valves to be provided

Table 4: Actuator operated valves

NO	DESCRIPTION	REMARKS
1	Reservoir Inlet Valve	Pipe line emptying prevention
2	Pump delivery valve- 4 Nos.	Sector-4
3	Pump delivery valve- 4 Nos.	Sector-5

L2.2.3.7.5 Power Distribution Arrangement

Power will be received from medium voltage distribution network of the supply authority. (Alternatively, possibility of obtaining from existing pump station to be considered) Contractor shall include in his scope to attend to all necessary civil works for the installation of metering equipment etc. as per the requirements of the supply authority. (In case power is to be obtained from existing pump station cable laying from the existing pump station shall be included). Contractor shall install outdoor disconnector / DDLO after the metering and before the incoming cable, for necessary isolation.

Medium voltage switchgear panel shall be installed in the electrical room. Cable connection is to be used for the connection to the disconnector / DDLO.

Medium voltage switchgear will be with a feeder for the 2000 kVA MV / 3.3kV transformer and cables will be used for the connection to the transformer.

P3.3kV switchgear panel will receive power from transformer and 3.3kV generator with interlocking arrangement.

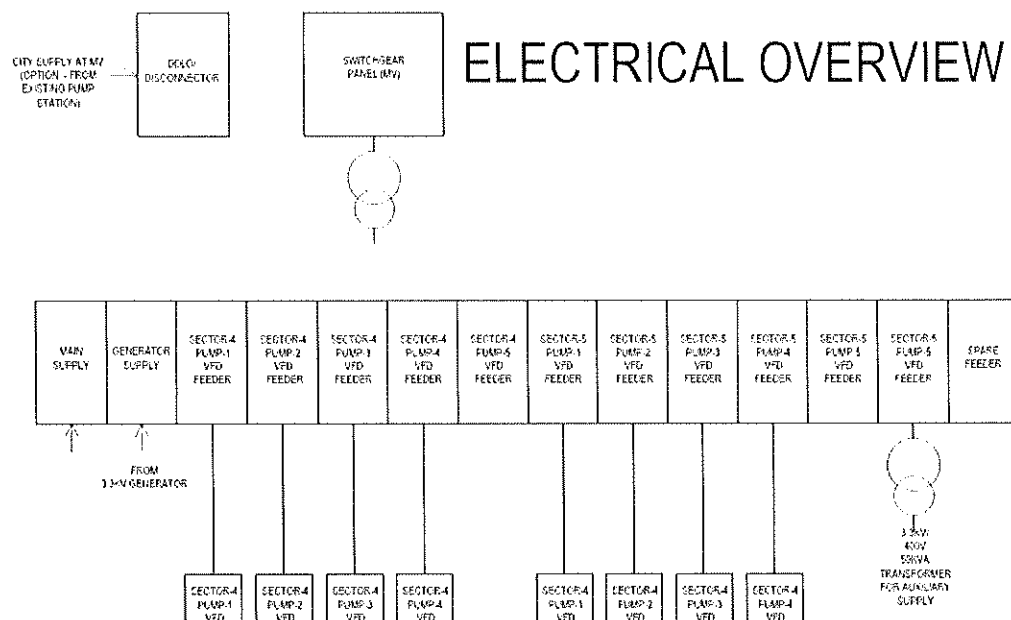


Figure 2: Power Distribution Arrangement at Kalurghat Pump House

L2.2.3.7.6 Power Transformers

Transformers to be provided are given in Table 4,

Table 5: Power transformer to be provided at Pump House

Location	Capacity (kVA)	Remarks
Outdoor	2000	Indicative rating
Pump building second floor	50	

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20X TR- 01

Power source: City distribution by supply authority / from existing Pump Station

Type: Oil immersed hermetically sealed, naturally cooled, double wound, core type.

Supply Voltage: Medium Voltage 11 kV / 33kV

Purpose: To step-down MV to 3.3kV

20X TR- 02

Power source: From 3.3kV Switchgear

Type: Dry type with enclosure for indoor installation. (Integral with 3.3 kV switchgear in separate cubicle is acceptable)

Supply Voltage: 3.3 kV supply

Purpose: To step-down 3.3kV to 400 / 230V for auxiliary power for the pump house

L2.2.3.7.7 Switchgear, VFD, Motor Control Centre (MCC), Local Operation Station (LOS), Local Control Panel (LCP) etc.

Table 5 gives the equipment list to be provided at the pump house,

Table 6: Equipment List to be provided

Description	Remarks
One incoming and one outgoing at city MV voltage	For main transformer with protections
Two incomings for city supply and generator supply and 12 outgoing including one spare	10 outgoing for main pump VFD's and one for station power transformer
Sufficient capacity for the main pump motor with minimum safety margin of 10%. For the current rating, actual power factor of the motor shall be considered.	Low harmonic type
Motor control Center (MCC)	Auxiliary power distribution, common control and MOV and pump control when MCC control mode is selected.
Local Control Panel for drain pumps	
Local operation station	Operation of equipment at close proximity for maintenance / under emergency conditions

L2.2.3.7.8 Generators

3.3kV diesel generator shall be provided and details are as per Table 6,

Table 7: Details of Generator

Location	Capacity (kVA)	Remarks
Generator building	1500kVA, Prime rated 3.3kV	Sufficient capacity for normal operation

Output Voltage: 3.3 kV

Purpose: To operate the main pumps during city power interruptions

Type: Diesel generator, open type, installed in sound attenuated building.

Installation: To be installed in generator building. Noise attenuation is to be obtained by providing noise attenuation walls, fresh air and hot air noise attenuators to reach residential noise requirements.

Diesel storage: Bulk diesel storage tank with sufficient capacity for 24-hour continuous operation generator at full load shall be provided. Diesel refilling arrangement meeting with local bulk supply diesel tankers shall be provided.

L2.2.3.7.9 Instrumentation, Control and Automation

Operation of this pump station shall be automated so that operator intervention is necessary only under special situation.

Automation and control system shall basically consist of following,

- (a) Instrumentation, control and automation ((ICA) panel.
- (b) SCADA computer.
- (c) Field instruments including outlet flow meter.
- (d) Remote control panels at ADC Hill ground reservoir for level and inlet valve monitoring.

L2.2.3.7.10 Instrumentation, Control and Automation (ICA) Panel

ICA Panel shall be provided in the pump station. It shall be with control PLC with sufficient capacity for controlling the pump station and coordination of all associated equipment.

ICA Panel shall be provided as indicated in Table 7 below,

Table 8: ICA Panel Details

Location	Purpose	Remarks
Pump Station	Control of pump station	
Iron Removal Plant (IRP)	Control of IRP	Control and automation of existing plant

Each ICA panels shall be with dedicated PLC's with sufficient control capacity for controlling the entire plant independently.

All ICA Panels and process interface PLC in SCADA room shall be connected with redundant fibre optic network laid in alternative routes.

ICA panels shall be with touch screen HMI for operator interface.

Communication between ICA panels, with SCADA computers or any other controllers which are not located within the building shall be by fibre optic cables.

All information available in the SCADA / ICA shall be made available through internet for accessing by computer / smart device. Software for such operation shall be included.

Additional fibre optic port shall be provided for communication with future equipment.

L2.2.3.7.11 SCADA Computer

Computer with SCADA software shall be provided to serve as operator interface for monitoring and control of the pump station. SCADA software shall be with data storage and processing capability for developing necessary reports as per the operator requirement. Additionally the system shall be capable of exporting data in csv or similar format readable and processable by standard software such as XLS.

Similarly new SCADA system is to be installed to replace the existing SCADA system in the plant and both systems shall be integrated.

Contractor shall assess the status of instruments, PLC wiring etc and include necessary modifications / replacement to ensure reliable operation for at least 5 years. Status report shall be submitted for approval before proceeding.

L2-2.3.7.12 Field Instruments

Instruments lists shown in Table 8 are to be provided,

Table 9: Field Instrument Lists

NO.	DESCRIPTION	TYPE	REMARKS
1	Reservoir inlet flowmeter	Electromagnetic	
2	Pressure transmitter on pump suction header		For reservoir level measurement
3	Pressure switch on pump suction header	Electro-mechanical type	For pump dry run protection
4	Pressure transmitter on pump common delivery-Sector-4		
5	Pressure transmitter on pump common delivery-Sector-5		
6	Flow meter on pump common delivery line- Sector-4	Electromagnetic	Note-1
7	Flow meter on pump common delivery line- Sector-5	Electromagnetic	Note-1
8	RCL analyser		

Note-1

Pump delivery flow meter readings are to be used as sector flow meters as well. Therefore, these readings shall be made available to the contractor for DMA / sector monitoring.

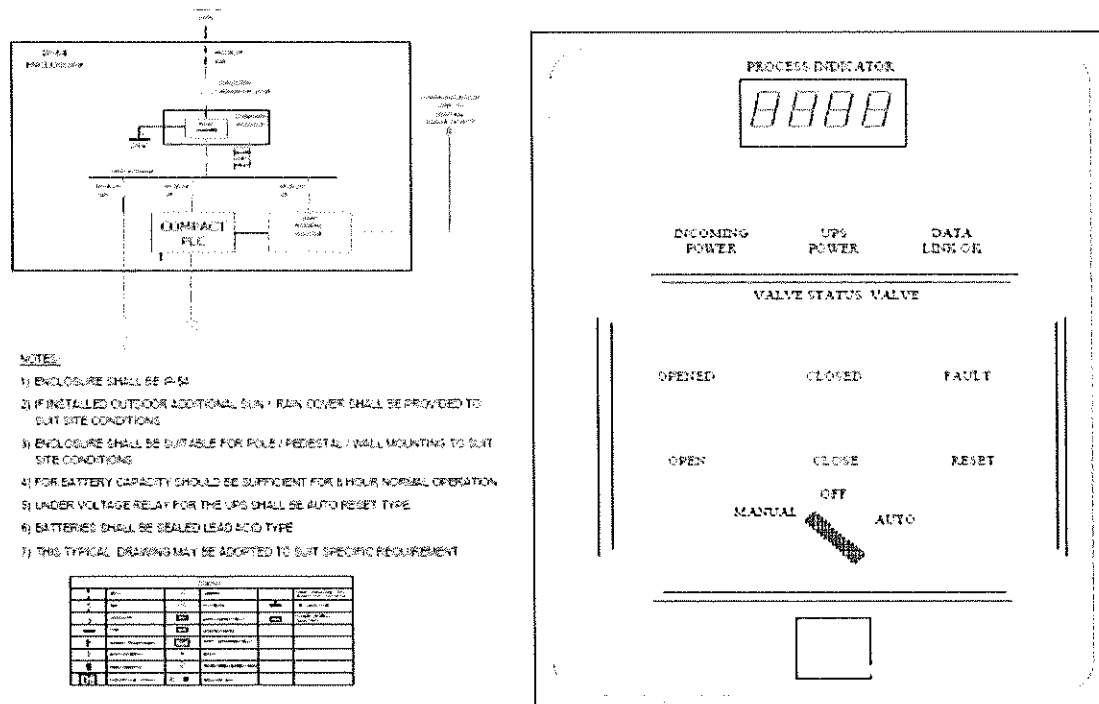
Wall mounted enclosure (approximately 600 x 450mm) close to the ICA panel, shall be provided under the scope of this contract with following interface,

- UPS power at 24V / 230V with breaker. (200Watts)
- Optically isolated pump delivery flow signals in 4-20mA format. (Sect-4 and 5)
- Removable mounting plate for third party hardware installation.

L2-2.3.7.13 Remote Actuation and Monitoring Panel (RAMP) Control Panels

Typical details of RAMP are indicated in the figure,

Figure 3: Remote Actuation and Monitoring Panel (Typical Details)



When information flow between remote sites are necessary RAMP are to be used,

Remote actuation and Monitoring Panels (RAMP) are to be installed as indicated in Table 9 below,

Table 10: Remote actuation and Monitoring Panels Details

NO.	DESCRIPTION	ASSOCIATED INSTRUMENTS	REMARKS
1	Roadside inline booster pump sites for monitoring delivery pressure, flow and other status signals	Pressure transmitter, flow meter.	Quantity as per the contractors detailed hydraulic analysis.
2	RAMP at Modunaghat Pump Station	Pressure transmitter on pump common	Purpose • Display the Kalurghat

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NO.	DESCRIPTION	ASSOCIATED INSTRUMENTS	REMARKS
		delivery	Reservoir Water Level • Transmit pipe pressure data to Kalurghat SCADA system • Provide 6 Nos. Pump run command signals for future use by third party.
3	RAMP at ADC Hill reservoir	Reservoir Level Transmitter, inlet and outlet flow meters	Purpose • To transmit reservoir water level, flow signals, any other status signals to Kalurghat Pump Station. • Optional control and monitoring of inlet MOV to the reservoir.
4	RAMP at Patenga Pump Station	Reservoir water level transmitters, flow meters	Purpose • To transmit reservoir water level, flow signals, any other status signals to Kalurghat Pump Station. • Optional control and monitoring of inlet MOV to the reservoir.

All RAMP shall be connected to SCADA computer with VPN connections from GSM service provider.

L2-2.3.8 Modifications to SCADA System at Patenga Pump Station

SCADA System at Patenga Pump Station Shall be modified to incorporate new pump control arrangement and integrate new equipment to the system so that fully automated operation is possible.

L2-2.3.9 Control Philosophy

L2-2.3.10 Note on Modunaghat Control Philosophy for Pumps at Modunaghat Pump Station

These pumps are required to operate under very low / negative static pressure condition. Therefore, the possibility of pump runout operation shall be eliminated by introducing artificial friction with delivery valve control at the time of one or two pump operation.

Additionally, the pipe emptying condition shall be avoided by immediate closing of the Kalurghat Ground Level reservoir inlet valve as indicated in the control philosophy.

L2-2.3.11 Control Philosophy for Reservoir Inlet Valve at Kalurghat

Manual Operation shall be possible as indicated below,

From the valve actuator head with push buttons under local selection.

From MCC from cubicle door with push buttons after selection of remote mode from actuator head.

When auto operation is selected from MCC following options shall be available, so that the valve is closed immediately when the transmission pumps at Modunaghat Pump Station are stopped. Consideration shall be given to using a pilot operated pressure sustaining valve in the reservoir inlet pipe as a passive alternative / back up to an electrically operated valve.

Dedicated UPS power shall be provided for the reservoir inlet valve to ensure immediate closure. Industrial type three phase UPS with capacity for 4 hour back-up at full load shall be provide for this purpose.

Based on drop in pressure at SR pump station common delivery transmitted from RAMP.

Based on drop in pressure in the inlet pipe before the MOV

Based on drop in reservoir inlet flow detected by inlet flow meter.

All these options shall be available in the SCADA for the operator to select most reliable.

Parameters for this operation shall be decided at the time of commissioning.

L2-2.3.12 Control Philosophy for Distribution Pumps (For both Sector-4 and 5)

Control philosophy is indicated in general section for distribution pumps, and the contractor shall use it as a guideline for the development of final control philosophy.

Final control philosophy shall be based on actual equipment and providing safe, reliable, operator friendly, energy efficient operation. Updated Control philosophy document shall be prepared by the contractor and submitted for approval at the time of implementation.

L2-2.3.13 Auxiliary Equipment

Auxiliary equipment as indicated below shall be provided,

L2-2.3.14 Drain pumps

Drain pumps shall be provided to pump out leakage water from the pump floor.

Minimum of two pumps in duty standby arrangement shall be installed.

Operation of the pump shall be automatic using level switch capable of detection of multiple levels in the pump pit. Status of the pump and the high-high water level shall be monitored by the ICA Panel.

L2-2.3.15 Overhead crane

Electrically operated overhead crane shall be provided for the pump room with sufficient capacity for handling the pumping set.

L2-2.3.16 HVAC works

HVAC works shall include,

Ventilation system for pump room, including suction and exhaust fans, ducts etc. to maintain 10 air changes per hour.

Air conditioning for the VFD room to remove VFD heat load with dedicated ducts.

Standard ventilation arrangement for other locations, Fire alarm and protection

Fire alarm and fire protection shall be provided as per local fire regulations.

L2-2.3.17 Improvement works at ADC Hill

Contractor shall carry out a detailed study / investigation for improvement works needed at ADC hill reservoir with preparing necessary drawings based on the detailed given in the indicative drawings. The design and construction work at ADC Hill reservoir premises shall include followings but not limited to:

- i) 1000mm dia. DI Outlet pipe and 1000mm dia. DI overflow pipe to be connected to the existing reservoir as per the indicative drawing with necessary valves arrangement.
- ii) 450mm dia existing inlet pipe to be connected to newly laid 1000mm dia DI pipe as per indicative drawings with bulk inflow meter and valves.
- iii) 1000 overflow pipe to be laid up to nearest discharge point (to be identified by the contractor with the approval of the Construction Supervision Consultant) with necessary chambers and outfall structure.
- iv) The existing scour pipelines to be connected to the chamber in the overflow line.
- v) Existing surface drainage system to be improved and rehabilitate wherever required to discharge stormwater and minimize the surface runoff.
- vi) All site works such as boundary (perimeter) fence with gate, access road, car park, block paving and necessary retaining walls and landscape works to be carried out as per the indicative drawings.
- vii) Carry out water tightness test for the reservoir (before and after the leak repairs).
- viii) Propose detailed leak repair analysis report which shall include drawings, method statement to minimize the leaks as per the specification and obtain the Construction Supervision Consultant's approval.
- ix) Demolition and disposal of unnecessary items out of the site (discharge site to be identified by the contractor and get approved from the Construction Supervision Consultant) and clean the site.
- x) Necessary repair works to the gate house and paintings works to the reservoir, gate house.
- xi) All necessary structural design and drawings.

L2-2.3.18 Yard Piping & Interconnection to the Existing System

Contractor shall provide interconnection to the existing system at Kalurghat, ADC Hill and Patenga as follows,

Kalurghat

- The delivery pipeline of the existing Kalurghat distribution pumps shall connect to the existing 1200mm DI transmission pipeline in order to transfer water to ADC Hill reservoir with the necessary valve control.
- An additional line from DI pumping transmission line to ADC Hill reservoir shall connect to the Mohara Transmission line (900mm dia.) with the necessary valve control.
- Delivery line pipeline from pump house to the pumping main for Sector 4 and 5 shall be laid as per the indicative drawings. Contractor shall select the suitable pipe alignment, subject to the approval of the Construction Supervision Consultant.

ADC Hill

Inlet and outlet pipe of ADC Hill reservoir to be connected to the existing system as follows,

- Inlet 1000mm dia DI pipe (Ex. 450mm to be replaced) to be connected to the existing 1000mm DI which a branch off from 1200mm dia pipe from Kalurghat. Necessary flow control Valve and section valve arrangement to be placed as required.
- The delivery pipe from the reservoir, 1000mm dia DI pipe (Ex. 450mm to be replaced), to be connected to existing 1000mm DI pipes which a branch off from 1200mm dia pipe from Kalurghat. Necessary flow control Valve and section valve arrangement to be placed as required.
- Additionally, there should be an arrangement to transfer water from the delivery line (from ADC hill) to 600mm / 700mm dia pipeline from Mohara with necessary valve arrangement.

Patenga

- Provide a Pressure Sustaining Valve / flow control and necessary valves at the junction to the Patenga pump house and inside the pump house premises, on the inlet Transmission line of 1200mm DI from ADC Hill Reservoir.
- Connection of existing delivery lines to the newly laid direct pumping line to Sector 1 with necessary valve arrangement.

L2.2.3.19 Pump Station near Chittagong Urea Fertilizer Company Area

- Design and Construction of a new Pump Station near Chittagong Urea Fertilizer Company Area to Convey 30 MLD water produced from Bhandaljuri Water Treatment Plant (BJWTP) to Sector 1 Area.
- Supply and Installation of Electro-Mechanical Equipment for the Pump Station.



L2-2.4 Work Section 2: DMA Establishment, Leak Reduction and Maintenance Work**L2-2.4.1 DMA Establishment**

The scope of work for each DMA to be established includes (but is not limited to):

- (a) Contractor shall carryout the DMA isolation works by supply and installation of all boundary valves and end caps as per approved detailed design drawings.
 - (b) Replacing existing service connections as per the standard drawings to replacement distribution pipe where existing old pipe has been replaced. All Materials required for the standard customer service connection shall be supplied as per the Specification. The work includes the supply and installing connection pipe between standard installation and existing meter by keeping necessary provision for installation of new customers meter by the CWSIP/G3 contractor.
 - (c) Identification of customer service connections that have to be relocated from a trunk or distribution main outside the DMA (or in a neighbouring DMA) to a distribution main inside the DMA and execution of that as per the standard drawing; The work includes the supply and installing connection pipe between standard installation and existing meter by keeping necessary provision for installation of new customers meter by the CWSIP/G3 contractor;
 - (d) The Contractor shall update and maintain a comprehensive GIS based customer database to align with DMA boundaries and submit to the Employer;
 - (e) Execution of zero-pressure-test and execution of all subsequent investigations and works should the first zero-pressure-test have failed until the test is successfully performed;
 - (f) Execution of a 7-day isolated supply test to identify any low-pressure areas within or adjacent to the DMA boundary; as part of the preliminary baseline assessment for the DMA. The test shall include continuous inflow measurement and pressure logging at selected points such as the inlet, critical point (CP), and average zone point (AZP). The data logging interval shall not exceed 15 minutes to ensure adequate resolution for analysis of low pressure areas within or adjacent to the DMA boundary.
 - (g) Construction of required RCC DMA inlet and monitoring chambers complete with double flange spool piece allowing replacing with the Smart Metering system by the CWSIP/G3 contractor.
 - (h) For all works carried out: reinstatement of road and sidewalk surface;
- Customer Service Connection Details

Meter Size (inch)	Numbers of Existing Service connections
0.75	18,116
1	1,347
2	71
4	19
6	3
8	-
Total	19,556

Note: It is expected to increase number of connections approximately by 14,400 during the Contract Period which will be installed by the contractors.

L2-2.4.2 Water Loss Reduction in DMAs

The Contractor shall take all necessary actions, provide all required services and materials and equipment and carry out all works required to achieve the main objective of the Contract and reduce Non-Revenue Water in the DMAs to less than 10% of the inflow upon investigation of water supply levels at the start of the project. The following (non-exhaustive) list summarizes the activities the Contractor shall have the capacity and experience required carry out as necessary (without limiting the Contractor's obligations and the scope of work): It should be noted that any quantities of materials or equipment specified as minimum requirements (e.g., pipes) shall be considered inclusive, and any additional quantities required shall be provided at the Contractor's cost.

- a. Replacement of existing service connections pipes in addition to under establishment of DMA as per the standard drawing; The contractor must permanently close the opening in HDPE distribution main with electro fusion plug unless the existing opening is aligned for the new a connection or repacking the certain length of the main facilitating many connections. Also, the work includes the supply and installing connection pipe between standard installation and existing meter by keeping necessary provision for installation of new customers meter by others.
- b. An initial water loss measurement shall be carried out as specified in specification section 5.2 after fixing customers and DMA meters (Meters shall be installed by the Package CWSIP/G3 Contractor).
- c. Pressure management: energy efficient stabilization and management of supply pressure to maintain a minimum supply pressure of at least 1.0 bar at the inlets to customer meters while preventing excessive DMA pressures developing during periods of low demand using VSDs on feeding pumps, control valves and such other means as may be appropriate. When doing pressure reduction, the Contractor shall ensure that the volume of water supplied to customers in the DMA is the same or better than the supply levels at the start of the project. Pressure management shall be done in close cooperation with the Employer and customers in the DMA to avoid customer complaints;
- d. Detection and reporting of illegal/ unauthorized practices (illegal connections, meter tampering or removal and bypasses);
- e. Leak detection surveys: (using all kind of equipment and technologies, ranging from simple sounding with a listening stick to advanced techniques such as ground microphones, leak noise correlators, and leak noise loggers, as appropriate. In areas with low pressure (<1.5 bar), or under intermittent supply conditions, traditional acoustic methods may be ineffective, particularly on plastic pipes. Therefore, tracer gas technology (e.g., hydrogen gas) shall also be employed where necessary to detect non-visible leaks. All required leak detection equipment shall be provided by the Contractor and will revert to the Employer at the end of the Contract.
- f. Leak repair on distribution pipelines: shall be performed using techniques and materials that ensure that the repair shall endure for at least the expected service life of the pipeline being repaired, for example, by installing repair clamps or replacing

pipe sections, all material supply, installation and road reinstatement works are included;

- g. Pipe Replacement: based on the leak detection surveys, repair records (repairs / km) and examination of pipe samples taken from repairs and test pits, the Contractor shall provide a cost-effective pipe replacement plan with financial justification to the Supervision Consultant. The pipe replacement works shall include supply and installation of pipelines and all fittings, including connection to the network, including, fine sand bedding and surround, pressure testing and disinfection, reinstatement of road or sidewalk surface.
- h. Installation of Appurtenances: supply and installation of sluice valves, air valves hydrants and such other works not identified under work section L2-2.1, complete with all fittings and materials required, including reinstatement of road and sidewalk surface.
- i. Retrofitting public stand posts with meter boxes and heavy duty self-closing taps to avoid water wastage;
- j. continuous monitoring and interpretation of inflow, pressure, minimum night flow and billed customer usage to respond to unexplained flow increases that may signal the appearance of new leaks or new unrecorded connections, or suspicious reductions in consumption that may indicate customer meter malfunctions or by-passing with surveys and remedial action to ensure that the level of NRW remains less than 10% of inflow;
- k. Any other works that may become necessary to achieve the 10% target level of NRW.
- l. Apply the same methodology for all DMAs within sector 1, 4 and 5 to maintain sector non-revenue water below the target level of 10% of sector inflow during the Maintenance Period.
- m. During the Water Loss Reduction Phase, the Contractor shall submit monthly summary reports for each DMA, detailing inflow volumes, supply pressures, minimum night flows, estimated customer consumption, and calculated NRW. The report shall also include a brief summary of water loss reduction activities carried out during the period, such as leak detection, leak repairs, and removal of illegal or unrecorded connections.

L2-2.4.3 Maintenance Work

L2-2.4.3.1 Maintaining the level of NRW

- a. The 12-month Maintenance Period will start once the Construction Supervision Consultant has confirmed that all the works under sub-section L2-2.4.2 have been completed for all DMAs to be established in Sectors 1, 4 and 5.
- b. Starting at the beginning of the third week of the Maintenance Period the Contractor shall provide fortnightly reports to the Employer and the Supervising Consultant recording inflows, supply pressures, minimum night flows, actual or estimated customer usage and NRW, to date from the start of the Maintenance Period and for the preceding 2 week period, together with a record of the Contractor's interventions

- in each DMA to contain and reduce water losses, such as step tests, surveys, leak repairs and the removal unrecorded connections and customer meter by-passes.
- c. The Contractor's fortnightly report shall alert the Employer to any circumstances outside the control of the Contractor, such as water shortages or supply interruptions, that have or may distort the measurement of NRW or help or hinder the efforts of the Contractor in the work of minimizing NRW and maintaining a minimum supply pressure of 1.0 bar.
 - d. In the event that the Contractor's fortnightly report shows that Sector NRW to date has exceeded the 10% target then Contractor shall immediately notify the Employer and the Supervision Consultant of the procedural changes and additional resources that the Contractor intends to employ for the remainder of the Maintenance Period to reduce current NRW to the level needed to achieve the final 10% target NRW on completion.
 - e. At the end of the Maintenance work, the Contractor shall provide a Completion Report which will include the supporting data, authenticated by the Supervision Consultant, quantifying actual NRW in each DMA and Sector throughout the Maintenance Period to determine whether the targeted NRW level has been achieved and the value of any Performance Bonus or Penalty due to the Contractor.

L2-2.4.3.2 Information transfer

- a. The Contractor shall ensure proper documentation of all assets and activities executed. For all works involving chambers and pipelines "as built" drawings and/or manuals shall be provided by the end of the 4th month of the Maintenance Period. The Contractor shall be responsible for the quality of the information on customers, assets and pipelines. During the Maintenance Section the Contractor shall transfer this information to the Employer through automated databases (customer database, GIS, as built drawings).
- b. The Contractor will ensure that Employer's staff know the physical location in the field of all the assets that have been developed, this includes, non-exhaustive; pipelines, customer meters, bulk meters, isolation valves etc.
- c. If the Contractor does not supply the drawings and / or manuals by the dates stated in the PCC, or they do not receive the Construction Supervision Consultant's approval, the Construction Supervision Consultant shall deduct an amount stated in the PCC from payments due to the Contractor.

L2-2.4.3.3 Knowledge transfer

- a. From the beginning of the contract up to end of the Maintenance Section, the Contractor will train minimum 20 staff from Employer and give minimum 20 days of theoretical and practical training through training workshops and 02 months of on work training to each staff. The contractor will transfer all technology to enable the Employer to take over DMA management, hydraulic modelling, maintenance of pressure reducing valves, leak detection scheduling and execution, leak repair management and all other activities required to manage the DMA system and maintain the achieved water loss levels.



- b. The Contractor may decide to bring Employer's staff in during Section 2.3.2. To improve transfer of knowledge, the Contractor shall propose the Employer's staff to the Construction Supervision Consultant.
- c. During Section 2.4.2, the Employer may decide to second water loss management and reduction staff to work jointly with the Contractor's staff on a daily basis for minimum 240 man months. The Employer will continue to pay salaries of seconded staff but the Contractor may pay incentive bonuses that are in accordance with bonuses paid to his own staff. Seconded staff will follow the Contractor's instructions and will work as part of the Contractor's team. The Contractor will ensure that it will follow all local labor laws with respect to the Employer's staff and will treat the same with equity and fairness.
- d. If the Contractor is unsatisfied with the performance of a seconded staff member, he will inform the Employer. If the unsatisfactory situation continues, the Contractor is allowed to reject further secondment of the staff concerned and the Employer may nominate a replacement.

L2-2.4.3.4 Training

- a. At the end of the Section L2-2.3.1, the Contractor shall submit a detailed Training and Transfer of Technology Program that will be based on the respective section of the Contractor's Technical Proposal but will also take the experience gained during Contract implementation into account. The Program will be approved by the Supervision Consultant.
- b. All activities in respect to training, transfer of technology and development of the asset management strategy are included in the Management Services Fee.

L2-2.5 Work Section 3: Rehabilitation of Iron Removal Plant at Kalurghat

The Contractor shall be responsible for designing and implementing rehabilitation works to ensure a continuous supply of treated water of minimum 40 MLD from existing 10 MGD facilities. The raw water supply, with allowable treatment losses, will be provided by others (Package CWSIP/W2 and CWSIP/W3 contractor) through the existing raw water transmission system. The contractor shall carry out detailed design for upgrading 10 MGD (Million Gallons per Day) the iron removal plant at Kalurghat for an output capacity 40 MLD with the treated water quality specified in section L2-2.5.1.5, as well as meeting the actual water quality test results once all existing DTWs (Deep Tube Wells) are in operation after rehabilitation under Package CWSIP/W2 and CWSIP/W3.

The proposed treatment process, based on the existing DTWs in operation, and the major components of the improved system are described below. The Contractor shall be required to review the process based on actual raw water quality results and optimise it for best performance. The current works shall be limited to the specified design capacity only. However, the Contractor shall incorporate reasonable provisions in the layout and design, such as space allocation and suitable connection points, to facilitate potential future expansion, including possible integration with the existing 5 MGD plant to make total production of 80 MLD at Kalurghat.

The following improvements are recommended for the existing 10 MGD (Million Gallons per Day) plant at Kalurghat, while keeping the existing 5 MGD plant unchanged and abandoning the existing tower aerators and sedimentation tanks. The Contractor shall make arrangements to temporarily divert the raw water supply from the existing 10 MGD plant to

the 5 MGD plant during construction works, ensuring a continuous supply of treated water through the 5 MGD plant. The proposed enhancements are illustrated in Figure 3, and the layout diagram with the proposed improvements is shown in the indicative drawings. The Contractor's treatment process shall include but not be limited to design and construction of following components:

1) Receiving Tank:

- a. The Receiving Tank shall be designed and constructed to collect water from all four DTW transmission pipelines, each to be equipped with an individual flow meter. Submersible pumps designed to feed zones of new spray nozzle aerators shall be provided and installed inside the Receiving Tank that shall supply the minimum required pressure at the spray nozzles while maintaining a constant water level at the Receiving Tank.

2) New Aerators:

The Contractor shall

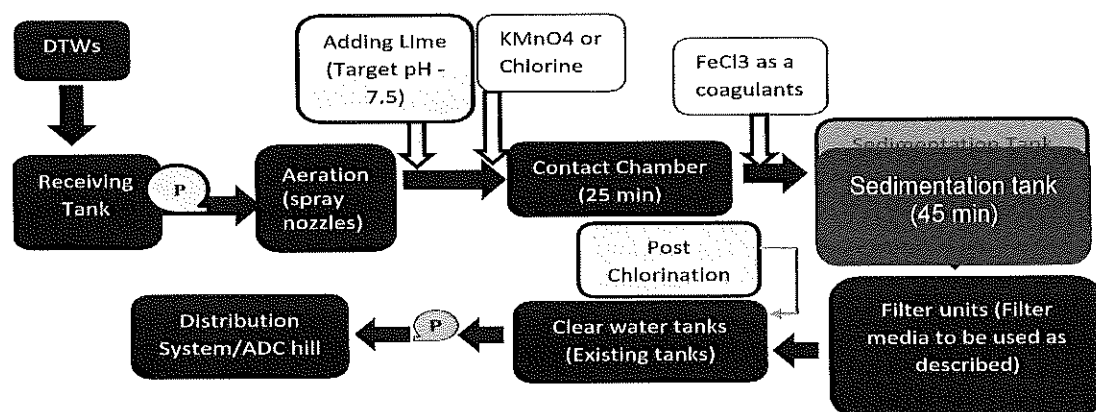
- a. disconnect, dismantle and remove the existing aerator towers (these are in very poor working condition, and spray nozzle type aerators are more suitable for the iron removal process).
- b. design and construct an aeration unit with spray nozzles or a functionally better alternative process, with a capacity of $1750 \text{ m}^3 / \text{hr}$ comprising a minimum of two units.
- c. provide an additional number equivalent to 10% of total number of installed nozzles as spares handed over to the Employer).
- d. design and incorporate a lime addition facility to control the pH after aeration at the level as stipulated in the design requirements.

3) New Contact Tanks:

The Contractor shall

- a. Design and construct two contact chambers for KMnO_4 , after the aeration unit.
- b. The contact chambers shall provide a contact time of 25 minutes to allow flexibility for the addition of chlorine if required.

Figure 4: Indicative Process for IRP at Kalurghat



4

4) New Sedimentation Tank

The Contractor shall design and construct a sedimentation tank with a detention time of 45 minutes with plate / tube settlers and a dosing facility for the addition of coagulants such as Ferric Chloride for better flocculation.

5) Improvement to the existing 10MGD Filter Bed and under drain system:

The Contractor shall:

- a. Replace the filter media in the 8 No. existing Rapid Sand Filters
- b. Supply and install a new filter underdrain system with all necessary pipe works to back wash the filters with air and water.
- c. Enhance the backwashing facilities by providing a connection and controls for taking backwash water with air at a higher pressure from the existing facilities at the 5 MGD plant (pump-driven water with an air blower).
- d. Incorporate an appropriate proportion of manganese dioxide (10 to 20% of the total load) to oxidize and trap residuals of non-oxidized manganese in settled water to both allow for a slight underdosing of KMnO_4 at the plant inlet and avoid the risk of pink coloration in case of a KMnO_4 overdose.
- e. Supply and install all associated pipework and motorized valves as described below.
 - o All filter control valves shall be replaced with electrically actuated valves and all necessary instruments for filter automation shall be provided.
 - o Filter control panel shall be located at the proposed Chlorination / Chemical House and be isolated from chemical atmosphere with necessary partitioning.

6) Converting Decommissioned Pump House Building to Chlorination / Chemical House, Generator House , and IRP Control Centre:

The Contractor is deemed to have visited and assessed the condition of the Existing Pump House Building adjacent to the 10 MGD Filter Beds in relation to the transformations required to convert it to serve as the chemical and gaseous chlorine storage, handling, mixing and dosing facility and control centre for the new and upgraded iron removal plant (IRP) specified above.

The Contractor shall:

- a. Design, supply all required materials, perform all the necessary works and dispose of all waste or discarded existing materials and equipment for the conversion of the existing pump building into a chemical and chlorine facility. The scope of the conversion shall include but not be limited to:
 - i. the supply and installation of all equipment required for the facility, such as lifting arrangements, solution preparation equipment, dosing systems and safety equipment. The contract ensures that all necessary equipment will be provided and installed to facilitate the smooth operation of the facility. Additionally,
 - ii. the provision of adequate storage solutions for each chemical, ensuring proper organization and compliance with safety regulations shall be provided.
- b. Chemical dosing facilities shall include:
 - i. Pre-Lime
 - ii. Pre and post chlorine
 - iii. Chlorine dosing to the ADC hill transmission main

- iv. Potassium permanganate (KMnO_4)
 - v. Ferric Chloride
 - c. Relocation of existing power generators system complete with the Decommissioned Pump House Building with proper separator wall and reestablishing all electrical connection to make sure electrical supply as required to the system.
 - d. Construction of extension building in western side of the Decommissioned Pump House Building to accommodate controls panels of the IRP in ground floor level and control room at the first floor to suite the requirements detailed in under (11) and shown in drawings.
 - e. Safety equipment shall include but not be limited to automated chlorine detection, neutralization and eye wash and shower facilities to meet the international standards.
- 7) Electro / Mechanical Works:**
- a. Replace or rehabilitate all necessary electro-mechanical instrumentation works.
 - b. Provide and install dosing pumps for lime, KMnO_4 , and chlorine, with provision for pre- and post-chlorination.
 - c. Provide and install static mixers at each mixing point to ensure effective blending.
- 8) Repair / Cleaning and Painting Works:**
- a. Carry out repair, cleaning, and painting works on the fabric of the old pump house, filters, and clear water tanks to improve their condition and appearance.
- 9) Yard Piping and Site Works:**
- a. extend the existing four raw water lines arriving from DTWs to the Receiving Tank
 - b. design, supply and construct new pipelines and, if needed, pumps to convey the treated water from the upgraded 10MGD filters and chemical dosing facility into to the existing clearwater tank.
- 10) Refurbish the existing Sludge disposal system**
- a. Design, supply and install sludge collecting pipework for the existing 5MGD and upgraded 10MGD iron removal plants.
 - b. Replace the existing sludge transfer pump design, supply and install a new agitation facility to prevent the accumulation of residual sludge in the tank.
- 11) Automation and control centre**
- The Contractor shall design, supply and install all sensors, CCTV cameras, wiring, power supplies, relays, instrumentation, PLCs, computers, displays and software needed to automate the operation of both the existing 5MGD and upgraded 10MGD iron removal plants in a purpose-built control room inside the existing building such that the operator's involvement is limited to high level commands only, such as specifying the chemical dosing concentrations, while operation of the plant components, such flow proportional feed rate control, shall be fully automated, with alarms and operator prompts to signal when routine maintenance interventions are required or equipment failures are detected. The Control Centre shall be separately ventilated air conditioned room housing the central PLCsm control panels and CCTV displays such that the operator on duty can monitor the operation of every component of the IRP, the quality of the incoming untreated water and outgoing treated water, pump and filter operations and tank levels and intervene as circumstances dictate.

12) Flow meters

All flowmeters shall be of the electromagnetic type and shall be properly sized and equipped for the flows and fluids to be measured, such as for the raw water inlet flow meters and meters required to support chemical dosing proportional to total inflow and outflow.

Contractor shall design and built all necessary structural elements, M&E equipment, control system design with all instrumentation works as given under design requirements.

13) Spare parts, tools and software

The Contactor shall supply all necessary spare parts for the maintenance of equipment/pumps for 5 years as recommended by the equipment manufacturers.

The Contactor shall supply two sets of standard and special tools necessary for maintenance of all equipment.

L2-2.5.1 Design and Rehabilitation of IRP Plant at Kalurghat**L2-2.5.1.1 Treatment Plant capacity**

- The total average treated water production output shall be minimum 40 MLD (40,000 m³/day) by from upgraded 10 MGD plant.
- Water losses including backwashing from the Treatment Plant shall not exceed 5.0% of the volume of treated water output. Water loss shall be defined as the difference between the raw water volume entering the plant and the treated water output from the Treatment Plant measured on a weekly basis.

L2-2.5.1.2 Performance of the Plant

- The Treatment Plant shall be capable of producing treated water to the specified quality, throughout the specified range of raw water qualities, for all output flows from 50% to 100% of capacity. The Treatment Plant shall be able to vary output from minimum to maximum within 12 hours, with no deterioration in treated water quality and shall be designed to operate efficiently throughout the above range of flows.
- The Treatment Plant shall be capable of producing water to the specified quality at the maximum design output when the following units are out of use: rapid sand filter being backwashed.

L2-2.5.1.3 Design Life Durability and Reliability All structure

- Each part of the works to be constructed and each item of plant to be installed under the Contract shall be designed to maximise reliability and minimise maintenance requirements and shall have a reliable operating life not less than the appropriate design lives stated below.

Description	Design Life (Years)
Reinforced Concrete Structures at IRP Plant	60
Mechanical and Electrical Equipment	20
Instruments	10

- “Design Life” shall mean the period of time for which an item or system is designed to operate at or in association with normal works full design output without major overhaul, serious corrosion or necessity for substantial renewal of any anti-corrosion system, reduction of efficiency or output in excess of 5%, or replacement of major components or components essential to the functioning of the item.
- The renewal of wearing parts such as bearings, diaphragms, shaft sleeves, seals or any other parts, which by virtue of their design and purpose are expected to be renewed within the above periods are accepted as exceptions only provided that those parts are manufactured to the requirements of the mechanical and electrical and instrumentation specification.
- Where replacement parts are anticipated to be required for any item of the works during the appropriate design life, over and the above the renewal of wearing parts meeting the Employer's Requirements, then these shall be identified by the Contractor. All spares shall be readily available.
- All items and systems shall be designed to allow replacement, major overhaul, etc at the end of the design life without requiring major work or dismantling of other items and systems which are of different design lives or interrupting the operation of independent items and systems.

L2-2.5.1.4 Raw Water Quality

- Raw water quality data for period of 2017 to 2023 shall be collected and used for the raw water quality analysis. Contractor shall collect all available water quality data for all DTWs sites. (Some of water quality data is given in Table 11 .)
- Contractor shall conduct all necessary tests for raw water from new DTWs once they are constructed by the Package 3 contractor.
- Summaries of minimum and maximum recorded water quality level based on the analyses done in 2023 & 2011 are shown in Table 11 and Table 12 respectively.

Table 11: Raw Water Quality Data Summary in 2023

No.	Name of BH	Sampling Date	Water Quality										
			Turbidity (NTU)	Alkalinity (mg/l)	pH	Total Hardness (mg/L)	Ammonia (mg/L)	Chloride (mg/l)	Arsenic (mg/L)	Manganese (mg/L)	Iron (mg/L)	Silica (mg/L)	Total Organic Content (mg/L C)
BD Standard Value			5	-	6.5 - 8.5	500	1.5	250	0.05	0.4	0.3 - 1.0	-	-
1	BH-1	May,08,2023	5.4	74	7.65	51	0.35	60	<0.01	0.2	0.06	110	<0.5
2	BH-2	May,08,2023	5.7	385	7.3	36	0.83	30	<0.01	0.1	1.47	595	<0.5
3	BH-3	May,08,2023	2	340	7.22	54	0.04	30	<0.01	0.1	0.4	145	<0.5
4	BH-4	May,08,2023	1.9	498	6.99	51	0.02	30	<0.01	0.2	0.65	55	<0.5
5	BH-5	May,08,2023	2	320	6.5	33	0.04	40	<0.01	0.1	0.16	55	<0.5
6	BH-6	May,08,2023	6.2	350	6.65	30	0.09	30	<0.01	0.3	1.22	230	<0.5
7	BH-7	May,08,2023	2.7	405	6.59	24	0.1	60	<0.01	0.3	0.91	255	<0.5
8	BH-8	May,08,2023	0.04	500	6.68	9	<0.01	40	<0.01	<0.01	0.14	840	<0.5
9	BH-9	May,08,2023	5.2	370	6.64	27	0.16	40	<0.01	0.1	1.28	470	<0.5
10	BH-10	May,08,2023	2	370	6.9	27	0.09	10	<0.01	0.1	0.14	415	<0.5
11	BH-11	May,08,2023	0.05	365	6.87	12	0.17	30	<0.01	0.2	0.33	265	<0.5
12	BH-12	May,08,2023	17.5	340	6.23	33	0.22	40	<0.01	0.3	1.53	165	<0.5
13	BH-13	May,08,2023	11.2	350	6.53	54	0.24	40	<0.01	0.2	0.86	240	<0.5
14	BH-14	May,08,2023	5.8	280	6.95	51	0.11	70	<0.01	0.1	0.52	102	<0.5

Table 12: Raw Water Quality Data Summary in 2011

No.	Name of TW	Sampling date	Water Quality								
			pH	Turbidity (NTU)	Cl	T-Fe	T-hardness (mg/l)	Alkalinity	Mn	No3 (mg/l)	TDS (mg/l)
1	No.1 TW	Jan,01,2011	6.72	22	20	6.7	95	112	0.5	1.2	135
2	No.2 TW	Jan,08,2011	6.68	18	20	5.6	92	110	0.4	1	130
3	No.3 TW	Jan,15,2011	6.92	32	22	7.2	90	115	0.6	0.8	128
4	No.4 TW	Jan,20,2011	6.81	22	18	6.9	85	112	0.8	0.9	137
5	No.5 TW	Jan,28,2011	6.8	26	22	5.2	86	140	0.5	0.8	160
6	No.6 TW	Feb,02,2011	6.84	30	20	5.2	65	98	1	1.2	138
7	No.7 TW	Feb,07,2011	7.08	12	18	8.2	125	130	1.8	1.2	112
8	No.8 TW	Feb,12,2011	7.8	16	22	5.2	72	112	0.8	1	135
9	No.9 TW	Feb,18,2011	6.84	20	30	1.5	78	110	0.4	1	138
10	No.10 TW	Mar,01,2011	7.12	10	32	5.4	110	95	0.6	1.3	158
11	No.11 TW	Mar,07,2011	7.32	12	15	2.2	86	92	0.4	1.2	108
12	No.12 TW	Mar,13,2011	7.48	19	22	6.2	62	94	0.3	0.8	102
13	No.13 TW	Mar,19,2011	7.23	20	25	4.2	72	86	0.4	2.1	132
14	No.14 TW	Mar,27,2011	6.82	12	15	7.8	92	140	0.9	1.5	158
15	No.15 TW	Apr,03,2011	6.68	36	35	15	110	120	1.2	1.3	162
16	No.16 TW	Apr,08,2011	-	-	-	-	-	-	-	-	-
17	No.17 TW	Apr,13,2011	6.68	25	45	6.8	92	112	0.4	0.8	240
18	No.18 TW	Apr,18,2011	-	-	-	-	-	-	-	-	-
19	No.19 TW	Apr, 25,2011	7.48	16	23	4.1	78	90	0.6	0.7	145
20	No.20 TW	May,01,2011	7.68	16	22	9.2	95	135	1.2	0.8	142
21	No.21 TW	May,08,2011	-	-	-	-	-	-	-	-	-
22	No.22 TW	May,12,2011	6.52	22	16	7.8	100	120	0.8	0.5	160
23	No.23 TW	May,18,2011	-	-	-	-	-	-	-	-	-
24	No.24 TW	May,24,2011	6.82	25	15	5.8	86	112	0.9	0.6	142
25	No.25 TW	Jun,01,2011	7.49	17	22	4.15	79	93	0.65	0.68	142
26	No.26 TW	Jun,08,2011	7.7	18	23	9.18	93	132	1.18	0.78	140
27	No.27 TW		-	-	-	-	-	-	-	-	-
28	No.28 TW	Jun,18,2011	6.55	21	17	7.82	101	11	0.84	0.49	161
29	No.29 TW		-	-	-	-	-	-	-	-	-
30	No.30 TW	Jul,23,2011	6.85	24	16	5.83	84	110	0.88	0.55	140
31	No.32 TW		-	-	-	-	-	-	-	-	-
32	No.33 TW	Jul,30,2011	6.84	30	20	5.2	65	98	1	1.2	138
33	No.34 TW	Aug,05,2011	7.01	10	16	8.1	120	128	1.78	1.18	110
34	No.35 TW	Aug,13,2011	-	-	-	-	-	-	-	-	-
35	No.36 TW	Aug,19,2011	6.98	11	17	8.18	118	128	1.79	1.18	110
36	No.37 TW	Sep,01,2011	-	-	-	-	-	-	-	-	-
37	No.38 TW	Sep,15,2011	-	-	-	-	-	-	-	-	-
38	No.39 TW	Oct,15,2011	-	-	-	-	-	-	-	-	-
39	Kopolock-2 TW	Nov,01,2011	6.78	20	32	6.2	90	112	0.9	1.2	162
40	Fulkoli TW	Nov,15,2011	-	-	-	-	-	-	-	-	-
41	Saiyed shah TW	Dec,06,2011	6.72	28	35	8.2	92	135	1.5	1.2	172
Average (Kalurghat No.1-41)						6.52		109.72	0.86		
Max. (Kalurghat No.1-41)						15		140	1.8		
Min. (Kalurghat No.1-41)						1.5		11	0.3		
Water Drinking Standard			6.5-8.5	10	<600	<1.0	<500	-	<0.1	<1.0	<1,000

L2-2.5.1.5 Treated Water Quality

- Iron and manganese concentrations shall follow the guideline stipulated in the WHO fourth edition of "Guidelines for drinking water quality" (2022) as summarised in Table 12
- Total Irons shall keep below 0.3 mg / l while for manganese shall keep below 0.08 mg / l.
- For each parameter (other than iron and manganese) the mean values over one year shall not exceed the target values set out in Column A of Table 13;

Table 13: Final Water Standards

Parameter	Units	A "Target"	B "Maximum"
(a) Physical Parameters - not directly related to health			
True Colour	Pt-Co units	5	5
Turbidity	NTU	0.5	1
pH	pH units	7.5 - 8.0	To achieve effective disinfection but minimise corrosion to pipes
(b) Inorganic Parameters - not directly related to health			
Aluminium	mg / l Al	0.05	0.2
(c) Microbiological Parameters - Health Related			
E-Coli	no / 100ml	0	0
Total Coliforms	no / 100 ml	0 (95% -ile)	0

- In addition, all water shall comply at all times with the following criteria relating to algal toxins (cyanotoxins) and shall have no objectionable taste or odour. The toxin levels stated refer to total concentrations, i.e. intracellular plus extracellular toxins:

Table 14: Algal Toxins (Cyanotoxins)

Parameter	Units	Maximum Value
Microcystins *	µg / l	1.0
Cylindrospermopsin	µg / l	1.0

* Total microcystins expressed as microcystin-LR toxicity equivalents

L2-2.5.1.6 Process main characteristics

- The proposed treatment process shall include following main characteristics (but not limited to)
 - PH adjustment
 - Aeration
 - Adding oxidants
 - Adding coagulants
 - Clarifier
 - Rehabilitation of Filter (with catalyst process)

- Disinfection

L2-2.5.1.7 Flow Metering

- Flow metering shall be carried out at the following points:
 - Raw water inlet (each of the four DTW lines);
 - Sludge flow from clarifiers
 - Filter backwash water on delivery to filters;
 - Treated water outlet;

L2-2.5.1.8 Hydraulic Design

- Treatment units and interconnecting pipes and channels shall be designed to convey the maximum design flow when the following units are out of service:
 - One clarifier out of use for maintenance;
 - One rapid gravity filter being backwashed and one rapid gravity filter out of use for maintenance.
- All interconnecting channels and pipes to, from and between treatment units shall be designed to convey the maximum design flow plus 10%.
- Structures, pipework layouts and devices which may cause severe hydraulic restrictions shall be avoided.
- Self-cleaning velocities shall be achieved wherever practical. Friction losses shall normally be based on the Colebrook-White formula. Alternatively, the Hazen-Williams formula may be used for pipe flow and the Manning formula for open channel flow. Additional consideration is required in estimating friction losses for sludge mains.
- A minimum freeboard of 300 mm shall be provided over calculated top water levels throughout the works at the maximum design flow with the units specified above out of service. Freeboard shall be in addition to the depth of flow over overflow weirs. All walkways and roof soffits over tanks shall be sited 150 mm clear of the allowance for freeboard. Where soffit slabs over channels and tanks have down stand beams the soffits shall be set to maintain at least the specified 300 mm freeboard specified.

L2-2.5.1.9 Plant Layout

- The Contractor may vary the arrangement of the plant process unit's layout to suit his own particular process designs and design of associated works subject to compliance with the Employer's Requirements. The layout shall maximise the unused area of the existing site to provide space for the construction of a possible future surface water treatment plant within the current boundaries of the site in addition to potential future expansion, including possible integration with the existing 5 MGD plant.

L2-2.5.1.10 Water Quality Monitoring

- Continuous on-line water quality monitors shall be provided for pH, turbidity and free chlorine. The sampling point for these monitors shall be at the outlet from the existing treated water reservoir 1. Continuous on-line water quality monitoring shall also be provided on the raw water transmission main for pH, turbidity, dissolved oxygen and conductivity. All other process control and performance monitoring shall be by

manual sampling at relevant points in the plant for analysis in the plant laboratory. Facilities shall be provided to enable samples to be taken at specified stages in the treatment plant for monitoring water quality

- Water quality monitoring requirements are detailed in Table 15.

Table 15: Water Quality Monitoring Requirement

Sample Point Location	Parameters	Frequency
Raw Water	Temperature	Daily
	Colour	Daily
	Conductivity*	Daily
	Turbidity*	Daily
	pH*	Daily
	Ammonia	Daily
	Iron	Daily
	Manganese	Daily
	Alkalinity	Daily
	Dissolved Oxygen*	Daily
	Jar Testing	Weekly
Dosed Water	Total Aluminium	Daily
	pH	Daily
Clarified Water	Turbidity	Daily
(on individual units)	Colour	Daily
	Total Aluminium	Daily
	Soluble Aluminium	Daily
Clarified Water	pH	Daily
(after lime dosing)		
Filtered Water	Turbidity	Daily
(on individual filters)		
Combined Filtered water	Turbidity	Daily
	Colour	Daily
	Total Aluminium	Daily
	Soluble Aluminium	Daily
Filtered water	pH	Daily
(single point after addition of lime or / and chlorine)	Free & Total Chlorine	Daily
Final treated water *	pH	Twice per day
	Colour	Twice per day

Sample Point Location	Parameters	Frequency
	Turbidity	Twice per day
	Iron	Twice per day
	Manganese	Twice per day
	Free & Total Chlorine	Twice per day

Sample Point Location	Parameters	Frequency
	Conductivity	Twice per day
	Total	Twice per day
Dirty backwash water	Turbidity	Monthly
Clarifier sludge (on individual units)	Total Dried Solids	Monthly or as required

Note * In addition to continuous on-line monitoring

L2-2.5.1.11 Sampling

- The location of the sample abstraction points and sampling taps shall be determined by the Contractor to satisfy the Employer's Requirements. The installations shall include for making the abstraction points and providing, installing and fixing all necessary valves, pipework and sampling taps and the provision and fixing of all necessary supporting racks and fasteners.
- Care shall be taken to ensure that manual sampling points provide an uncontaminated representative sample with attention being paid to pipework material and sample flows.
- All sample points shall be clearly and unambiguously labelled to identify the origin of the sample. The minimum size of sampling lines, valves and taps shall be 13mm, except for sludge where the minimum size shall be 25mm. Sampling lines may be either flexible or rigid and shall be kept as short as possible. Flexible sample lines shall be laid on horizontally mounted trays and shall be held in position using releasable ties / clips to give a neat appearance and to prevent movement under flow conditions.

L2-2.5.1.12 Process Instrumentation Requirements

- In addition to instruments specified as incorporated in particular parts of the Plant, the Contractor shall provide process instrumentation to monitor specified parameters at the specified locations as set out in Table 16. These are the minimum requirements and the Contractor shall provide any additional instrumentation required to suit his particular equipment or design and to enable the plant operators to monitor the performance and sufficiency of the treatment process.

Table 16: Process Instrumentation

Key:

I = Local indication

R = Recording and transmitting to Administration Building with repeat indicators in the

filter control gallery

T = Totalisation

Location	Parameter	Key	Alarms
Raw water prior to flash mixing	Flow	IRT	
Sludge flow from clarifiers	Flow	IRT	
Location	Parameter	Key	Alarms
Each individual filter	Loss-of-head	I	high
Filter washwater on common delivery to filters	Flow	IRT	
	Pressure	I	
Washwater storage tank	Level	I	
Filter air scour	Flow	I	
	Pressure	I	
Filtered water	Flow	IRT	
Chlorine contact tank	Level	IR	high
TW Res. - each compartment	Level	IR	high
- each compartment	Level	IR	low
- common outlet	pH	R	
- common outlet	Turbidity	R	
- common outlet	Free chlorine	R	
Service water	Flow	T	
Treated water output from plant	Flow	IRT	

L2-2.5.1.13 Process Unit Guidelines

1. Oxidation	- Aeration with oxidants – Spray nozzle aerators or more efficient method. Shall provide a minimum of two units. - Preferred Chemical oxidants: Potassium permanganate. Shall keep provision for chlorine / chlorine dioxide - Dose Rates - Normal 50 mg / l (maximum 100 mg / l) as Potassium permanganate. Actual dosage shall vary with turbidity, iron and manganese level of incoming raw
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	water. • Storage Requirements - 90 days at normal dose • Handling Requirements – 2 No. Dissolving Tanks with minimum 25 minutes of contact time allowing for provision for chlorine / chlorine dioxide • Dosing Concentration - 10 % maximum • Control - Manual adjustment of pump speed with local start-stop and remote control
2. Coagulation (Optional)	• Preferred Coagulant - Ferric chloride, FeCl_3 • Dose Rates - Normal 50 mg / l (maximum 100 mg / l) as Ferric chloride. Actual dosage will vary with turbidity of incoming raw water. • Storage Requirements - 3 months at normal dose • Handling Requirements - No. of Sedimentation Tanks - 2 with 45 min detention time + plate / tube settlers. • Dosing Concentration - 10 % maximum • Control - Manual adjustment of pump speed with local start-stop and remote control
3. pH Adjustment	• Preferred Chemical - Slaked Lime $\text{Ca}(\text{OH})_2$ delivered as Quick Lime (CaO) • Dose Rates - Normal maximum 30 mg / l as $\text{Ca}(\text{OH})_2$ (maximum dose 60 mg / l) • Storage Requirements - Area for slaking Quick Lime or lime slaker tank, 2 Dilution Tanks, 2 Dosing tanks with 30 hours storage at maximum dose. • Dosing Concentration - 5 % maximum • Control - Manual adjustment of pump speed with local start-stop and remote control.
4. Rapid Mixing	• Preferably directly into pipe or channel employing an in-line static mixer / mechanical mixing as flash mixing

5. Sedimentation / Clarifier	Type - Horizontal Sedimentation, unless algal problems are likely. Plate or tube settlers may be used. <table><tr><td></td><td>Rectangular Horizontal</td><td>Circular radial</td></tr><tr><td>Retention time</td><td>45 min with plate or tube settlers</td><td>1.5 m / h</td></tr><tr><td>Surface Leading</td><td>1.5 m / h max</td><td>1.5 m / h max</td></tr><tr><td>Surface loading Plain tank (with lamella flow)</td><td>5.0 m / h max</td><td>5.0 m / h max</td></tr><tr><td>Length: width ratio or Diameter</td><td>4 min : 1</td><td>30 m max</td></tr><tr><td>Depth</td><td>3m minimum (depth must be adequate for installation of tube or plate settlers and mechanical desludging equipment)</td><td></td></tr><tr><td>Horizontal flow Velocity</td><td>12-41 m / h</td><td></td></tr><tr><td>Outlet weir overflow rate</td><td>10 L / s / m width max</td><td></td></tr></table>		Rectangular Horizontal	Circular radial	Retention time	45 min with plate or tube settlers	1.5 m / h	Surface Leading	1.5 m / h max	1.5 m / h max	Surface loading Plain tank (with lamella flow)	5.0 m / h max	5.0 m / h max	Length: width ratio or Diameter	4 min : 1	30 m max	Depth	3m minimum (depth must be adequate for installation of tube or plate settlers and mechanical desludging equipment)		Horizontal flow Velocity	12-41 m / h		Outlet weir overflow rate	10 L / s / m width max	
	Rectangular Horizontal	Circular radial																							
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Outlet weir overflow rate	10 L / s / m width max																								
6. Rehabilitation of Rapid Gravity Filtration	- The existing 8 number of filters shall be rehabilitated and filter media shall be designed as per given guideline below. Contractor shall make sure to keep filtration rate as follows - Sand shall be mixed with manganese dioxide (10 to 20% of the total load) to oxidize and trap residuals of non-oxidized manganese which could subsist in the settled water. - Media Size Range - effective size: ≤ 0.75 mm, Uniformity Co-efficient (i.e. ratio of 60% size to 10% size) less than 1.7 - Depth of sand media - 1000 mm minimum - Support media Depth - 250 mm minimum (depends on type of under drain and nozzle system used)																								

	- Media loss - Not greater than 2% per annum. - Total filtration area - Approx.: 220 m² - Filtration rate - Maximum allowable filtration rates for sand media as specified shall be: - when all filters are in operation 7 m / hr - when one filter is being backwashed 9 m / hr
7. Filter Backwashing	- Shall allow backwash with air and water - to improve the cleaning of the sand filter media, - to upgrade the turbidity of the filtered water - to reduce the quantity of backwash water. - Filter bed shall be modified to suit backwashing with air and water from dedicated backwashing pumps. - Backwash frequency - Once per day per filter - Backwash time minutes (air 3-5 minutes and water 7-10 minutes) - Backwash rate - air 30-60 m / h, water 40-60 m / h - Initiation - Auto and manual operation possibility with manual initiation on time elapsed or head loss - Filter Backwash Water Recovery - To be provided where possible
8. Disinfection	- Chlorination - Chlorine Gas in 1 tonne drums - Dose Range - 0-10 mg / l (normally 5 mg / l) - Storage - 2 months at normal dose - Control - Manual adjustment of regulator. Automatic changeover of drums.

L2-2.5.1.14 Aerator and Inlet Chamber

Spray nozzle aerators shall be provided on a level such that gravity flow can be maintained for clarification and filtration. An overflow weir shall be provided, capable of passing the maximum design flow. Following chemical mixing, a flow division chamber shall be provided to distribute the flow equally between the sedimentation tanks. The flow division weirs shall have adjustable stainless steel weir plates.

L2-2.5.1.15 Mixing/Chemical dosing

The methods used for chemical mixing shall provide uniform dispersion of the chemical in the main flow of water at all times over the entire range of flows through the works. Static mixers shall be in-line mixers comprising fixed mixing elements installed in a housing of equal diameter to the pipe.

Mixer internals shall be of material resistant to the chemicals to be used on the plant. Inlet and outlet connections of the housing shall be plain ended suitable for flexible couplings.

Except where stated below, dosing of chemicals into pipelines shall be by lance type injectors extending into the pipeline for at least one quarter of the pipe diameter.

Injection lances shall be provided with nozzles to give an efflux velocity not less than 1 m / s. The injectors shall be stainless steel or lined as appropriate and shall be provided with isolating and non-return valves.

L2-2.5.1.16 Clarifiers

Clarifiers shall have perimeter walkways to enable the works staff to inspect the settlement process and the decanting weirs. Walkways shall have a minimum width of 1.2 m or such other width as required by Occupational Health and Safety regulations.

L2-2.5.1.17 Filters

The filter media, bed, floor, outlet arrangements and control system shall be designed to avoid pressures less than atmospheric occurring in the beds under all operating conditions and to prevent 'dry bedding' during or following a wash cycle.

The filters shall be designed such that each individual filter shall operate continuously for a minimum period of 24 hours between backwash operations under all conditions of flow and while maintaining the filtered water quality standards.

The design shall eliminate as far as possible any tendency to scour the media particularly during filling and to prevent the loss of filter media during washing.

Manual filter drains shall be provided to enable each filter to be completely drained for maintenance purposes.

Filter feed channels, vertical shafts, chamber floors etc. shall have valved drains which shall discharge to the drainage system.

L2-2.5.1.18 Filter Floors and Underdrains

The filter floors shall either comprise laterals and nozzles set in a concrete screed or be of the suspended floor type with nozzles or the Contractor's own equivalent. The filter floor design including the number, type and design of nozzles shall be based on proven practice.

The design of the floors shall ensure uniform distribution of the incoming filtrate, air and wash water over the complete filter bed area.

Fittings forming part of the filter floor shall be of corrosion resistant material. Metal fittings including bolts and clamps for holding down floor plates shall be of stainless steel.

The nozzles shall be of the screw-in type and shall be designed to prevent loss of filter media through the filter floor, either with or without the use of gravel layers.

Replacement filter nozzles shall either be available from a representative of the manufacturer in Bangladesh or be interchangeable with nozzles manufactured in Bangladesh. The



Contractor shall demonstrate this to the satisfaction of the Construction Supervision Consultant prior to supplying the nozzles.

L2-2.5.1.19 Filter Washing

Filter washing shall be designed for efficient cleaning of the media without excessive wash water consumption and shall incorporate sequential air scour and water washing.

The Contractor shall design his filter wash regime and the sequence and automatic control of wash operations based on proven experience with his chosen media.

The Contractor may, if appropriate to his own design, incorporate a surface cross wash to assist waste removal from the surface of the bed.

Control panels for each filter shall be located in the IRP control room. The control panel shall incorporate a loss of head gauge indicating the head loss across the filter media.

The control and operation of the backwashing system shall be carried out automatically using a PLC controller, with provision for manual initiation of backwashing.

Water and air for the filter backwash shall be obtained from the existing backwash water and air system provided at the 5MGD plant. This work shall include providing necessary interlocking arrangement to prevent simultaneous operation of filter washing and ensure only one filter is washed at any given time. All necessary piping and accessories shall be included.

The Contractor's filter washing control design shall include facilities for controlling and adjusting the wash water and air flow rates to adequately compensate for changing water temperatures during the year.

L2-2.5.1.20 Sludge Removal

A manually operated hydraulic sludge tank is available at IRP site and shall be used to receive all sludge discharge pipes from sedimentation tank, necessary pipes shall be designed and laid by Contractor.

L2-2.5.1.21 Chemical/Chlorine Building

The existing decommissioned pump house building shall be rehabilitated for use as chemical and chlorination building and control room for both the 5 MGD and 10 MGD plants and associated new works. The Contractor shall utilize the area efficiently for all chemical and chlorine dosing equipment's installation and storage.

The chemical plant area shall be designed for receiving, handling, storage, solution / slurry preparation, metering, transfer and dosing to points of application of the chemicals (Lime, KMNO_4 & FeCl_3) to be used in the treatment process. The chemical plant shall be located and arranged in chemical and chlorination buildings as specified.

The Contractor shall design, supply and install the complete system for each chemical and shall include chemical solution / slurry preparation and storage plant, chemical transfer systems, pumps, pipe work, valves, overflows, drains, filter equipment, chemical handling, lifting equipment, weighing equipment, fittings, power and water supplies (including appropriate treatment where necessary to minimise carbonate precipitation effects), instrumentation and control systems together with systems for administering chemicals to the points of application and all other accessories specified and required to provide a comprehensive chemical plant in all respects.

All chemical mixing tanks should be made of stainless steel which shall withstand corrosion and erosion by the chemicals used in the process.

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Chemicals to be used in the treatment process shall be as Contractor's final process. (as indicated, potassium permanganate, chlorine, lime, ferric chloride shall be used in this plant).

Sufficient areas shall be provided for 90 days' storage of each solid chemical, based on the assumed average dosing rate stated in the section L2-5.2.3.13 and the maximum design capacity of the water treatment plant. Storage areas for bagged chemicals shall be divided into two for each chemical by a wall 2 m high to encourage the rotational use of the chemicals. A wall at least 2.5 m high shall separate storage areas for different chemicals. A mechanical dust extraction system shall be provided in all chemical storage areas. Storage requirements for chlorine shall be as stated in the Table 17: Minimum Requirement of Chemical Storage.

Table 17: Minimum Requirement of Chemical Storage

Chemical	Form	Packaging / Delivery Consignment Size
Ferric Chloride	Kibbled	50 kg bags
Lime	Hydrated lime	50 kg bags
Chlorine	Gas	1-tonne / 900 kg drums or 80 kg cylinders as specified.
Potassium permanganate		

All drainage in the chemical building shall flow by gravity to the site general drainage or, where this is impossible, by automatic sump pump designed for the materials to be handled.

Chemical storage shall be under cover. The chemical storage area shall incorporate all plant necessary for the transfer of chemicals from storage either by hoist or hand operated bag trolley, preparation of solutions, dosing plant and associated local control and motor control centres.

Interconnecting ducts and service ways shall be of adequate size to enable wet chemicals and electrical services to be segregated and to facilitate ready access for maintenance purposes. Service ducting shall be drained.

The layout of the chemical storage and the associated dosing plant shall facilitate easy access by the operating staff and shall be arranged in a logical sequence. Particular care shall be taken in the segregation of lime, PAC or other dirty and dusty chemical handling areas from machinery or clean areas. The layout of the chlorine plant areas shall conform to the relevant technical standards and literature by chlorine manufacturers and plant manufacturers.

Lorry access shall be provided up to all chemical storage areas including the chlorine drum store. The main doors to the chlorine drums store shall be fitted with folding shutter doors to permit unloading of drums using an overhead crane system.

Outward opening emergency exit doors fitted with panic latches shall be provided from the chlorine drum stores.

Provision shall be made for the protection of all floors, ducts, drains, sumps and other surfaces including walls to a height of 1m above floor level, against chemical attack due to chemical leakages and splashes. The method of protection shall be subject to the approval of the Construction Supervision Consultant before installation.

There shall be adequate washdown points at all levels of the chemical building, with drainage points provided throughout.

L2-2.5.1.22 Chemical Handling

Manually operated bag handling systems shall be provided in the chemical areas to assist in the handling of chemicals.

The tanks shall be at a height above operator floor level convenient for manual loading. Where powdered chemicals are being used, they shall be transferred from bags using a fully enclosed, dust-free system to prevent the release of chemicals into the surrounding environment

L2-2.5.1.23 Preparation of Solutions

Batch mixing of solutions and slurries shall be carried out manually including changeover from empty to full-service tanks, transfer of chemicals and dilution to pre-selected solution strengths where required.

Solution and slurry tanks shall be of stainless steel. Ferric chloride tanks shall be protected from acid attack by a suitable coating on all surfaces exposed to both solid and liquid forms.

L2-2.5.1.24 Dosing Pumps

Chemical dosing pumps shall be of the piston diaphragm type with electronically controlled dosing, each with digital stroke adjustment and its own motor, with the exception of chlorine which shall be by pressure injection.

Dosing pumps shall be provided with standby units but the selection of duty and standby pumps shall be by manual / auto selection by the operator. When a changeover from a duty pump to a standby pump is required, the appropriate suction and delivery isolating valves shall be manually operated. All dosing pumps shall work against pressure sustaining load valves.

Flushing connections shall be provided for each dosing pump and each pump shall be provided with drip trays piped to waste.

Pump stroking speeds shall be selected to minimise wear taking into account the chemical being dosed.

Each dosing pump shall be provided with all necessary valves to suit the application. Any connecting manifold system shall be provided with flushing and drain connections. Means shall be provided for calibration of the pumps by direct measurement just downstream of the loading valves. Tappings off the service water supply, suitable for hose connections, shall be provided in each chemical area for flushing chemical spillage and for general cleaning purposes. Provision shall be made for drainage of the area and for protection of surfaces against chemical attack.

Dosing pumps and metering units shall meet the requirements of the general mechanical and electrical specification. The Contractor shall confirm with pump manufacturers that pump materials and design are suitable for the specific application and arrangement proposed. The Contractor shall also confirm with the manufacturer his recommendations for location / sizing of pulsation dampers, type of load valve and pipework configuration. Pump outputs shall be adjusted by manually changing the stroke length or by another method as necessary for the selected equipment so that dosing rate corresponding to the full plant capacity is set according to the lab tests. Any change necessary due to change of flow shall be taken care of

by PLC. Description of chemical feed automation shall be submitted for approval before proceeding.

L2-2.5.1.25 Chemical Transfer Pumps

Pumps for transferring chemicals shall be of the end suction centrifugal or progressive cavity or reciprocating type. Pumps of plastic construction shall not be used.

Pumps shall be provided with facilities for draining and flushing with water manually.

L2-2.5.1.26 Chemical Pipework and Valves

Chemical pipework and valves shall meet the requirements of the general technical specifications and shall be suitable for the chemical being handled.

Dosing pipelines shall be provided in duplicate (1 duty, 1 standby) with manual changeover facilities. Lime slurry delivery lines shall be in clear reinforced polyethylene tubing.

Dosing lines external to buildings shall be located in reinforced concrete trenches with removable reinforced concrete covers, for ease of access. The tops of the trench walls without the covers shall be set 25 mm above finished ground level. The covers shall be designed for pedestrian traffic. Lines under roads shall be laid in ducts.

L2-2.5.1.27 Mimic Diagrams

A static mimic diagram of dimensions not less than 1.0 m x 2.0 m shall be provided for each chemical, indicating the main elements, interconnecting pipe work and instrumentation.

The material shall be melamine laminate / phenol resin bond cross webbed having a press bonded aluminium centre core. Low molecular weight melamine formaldehyde laminating inks of various colours shall be used in a screen-printed process on laminating paper, laminated into the diagram material. The diagram and legends shall not be affected by mild abrasion or acid conditions, condensation, grease, oil or similar substances. The diagram surface shall be finished in silk-matt.

Different colours shall be used to represent different chemicals and services. A1 Full size drawings shall be submitted for the approval of the Construction Supervision Consultant before preparation of the artwork. The diagrams shall be suitable for wall mounting in the chemical areas and shall be located as directed by the Construction Supervision Consultant.

Additionally mimic diagrams to the same specification and of dimensions not less than 500 mm x 500 mm depicting each area of operation shall be provided and installed local to the respective area.

L2-2.5.1.28 Safety Equipment

The following minimum safety equipment shall be provided at the treatment plant:

- Eyewash bottles and irrigators
- Eyewash bottles each of 450 ml capacity and irrigators each holding 10 litres of boric saline solution. Eye wash bottles and irrigators shall be housed in cabinets mounted local to the chemical plant areas.
- Safety showers and eye baths
- Safety showers and eye baths shall be provided at the following locations:
- adjacent to alum saturators

- lime bag handling areas (eye bath only)
- chlorine building exits
- The showers and eye baths shall be connected to the service water mains and shall have header tanks to permit use in the event local of mains water not being available.
- Protective clothing
- Four sets of overalls, gauntlets, gloves, goggles and boots housed in storage lockers shall be provided.
- Portable gas detectors
- Four portable gas detectors (two each for oxygen deficiency and chlorine detection) shall be provided.
- One of the oxygen deficiency monitors shall indicate whether the atmosphere is safe by indicating 'go / no go'. The other monitor and the chlorine monitor shall display gas concentration and alarm messages.
- The oxygen deficiency monitors shall have:
 - Measurement range : 0 to 25 %
 - Resolution : not greater than 0.1% vol
 - Accuracy : within 0,3% vol oxygen in the range 18% - 24%
 - Instantaneous alarms : Oxygen deficiency 19 %
 - Oxygen enrichment 23%
- The chlorine monitors shall have:
 - Measurement range : 0 to 99.9 ppm
 - Resolution : not greater than 0.1 ppm
 - Accuracy : within 1 ppm at 20 ppm
 - Instantaneous alarms : 5ppm
 - Alarm for short term exposure limit of 15 minutes: 1 ppm
 - Alarm for time-weighted average over 8 hours : 0.5 ppm
- Ferrous iron shall be indicate by a flashing light and audible alarm. The alarm reset function shall be capable of being initiated only within a short preset time (e.g. 60 seconds) of the instrument being switched on.
- Each detector shall be pocket size and housed in a tough, durable case and sealed against dust and water ingress to IP 65. They shall have liquid crystal displays have software compatible with year 2000.
- The detectors shall be powered by rechargeable batteries and supplied complete with:
 - Battery charges;
 - Carrying cases and straps;
 - Sensor filters;
 - Gas calibration kit for each gas;



- Bulb operated hand aspirator to facilitate pre-entry checks (oxygen deficiency detectors only);
- Ball floats to prevent water being drawn into the detector (oxygen deficiency detectors only).
- First aid kits
- Two first aid kits shall be provided and installed in the laboratory and the administration building.
- Each first aid kit shall be supplied in a green hard-plastic carrying case clearly marked with a white cross and with the words FIRST AID KIT in appropriate Sri Lankan languages and English. A wall mounted cabinet shall be provided in which the first aid kit can be stored.
- Each kit shall comprise:
 - 10 Assorted Plasters
 - 3 Medium sized Sterile Dressings
 - A large Sterile Dressing
 - 1 Extra Large Sterile Dressing
 - 1 Sterile Eye Pad
 - 1 Triangular Bandage
 - 6 Safety Pins
 - 1 Pair Rubber / Plastic Gloves
 - Antiseptic Wipes
 - 2 Saline Solution Eye Pods
 - 3 Rolls of Tape
 - 1 Resuscitator
 - 1 Pair of Scissors

Chemical System - Scope of Auto / Manual Control Through SCADA System

Entire chemical system operation (Including Pre-Post) Chlorination, KMnO_4 / Lime / ferric chloride or any other process chemical dosing systems shall be linked to SCADA system for operation and monitoring possibility of dosing rates, chemical composition of pre-post dosing of water shall be nominated and adjusted through SCADA. This application of SCADA system shall be introduced to all stations where chemical dosing systems are introduced.

Coagulant Recirculation / Transfer Pumps

At least two recirculation / transfer pumps (one duty / one standby) shall be provided for recirculation and transfer of coagulant solution from the saturators to the batching tanks. Each pump shall be rated for a flow that allows transfer of sufficient saturated solution to provide 12 hours supply in 1 hour.

Suction and delivery pipework shall be arranged so that by manual operation of valves solution can be pumped from any saturator to any service tank.

L2-2.5.1.29 Batching Tanks

Each tank shall be provided with all necessary water inlets, overflow, drain and outlet pipework, manual valves and fittings, and a direct reading level gauge (float and calibrated gauge type).

In-line plastic strainers or other approved mesh screens complete with valves to permit screen cleaning shall be provided on each outlet pipe at an accessible point external to the tank. Drains shall not be less than 50 mm diameter.

Each service tank shall be provided with a suitably protected turbine agitator with motor and reduction gear unit. The agitator shall be mounted on girders so that the gearbox may be removed easily and replaced without entry of personnel into the service tank.

The turbine agitator control gear 'stop / start' push buttons shall be located adjacent to the service tanks on the local control panel. The service tanks shall be provided with a suitably valved outlet manifold assembly serving the dosing pumps.

The tanks shall be re-fitted with all necessary coagulant inlet and outlet, overflow and drain pipework, and a service water inlet. Each tank outlet shall be fitted with an in-line strainer and guard valve

L2-2.5.1.30 Power supply

Contractor shall provide power distribution, cables, control panels etc. necessary for new equipment.

Power is available in the existing plant location and expected to be sufficient for additional new equipment.

However, Contractor shall recheck and confirm. If additional power is necessary Contractor shall include necessary changes to the scope.

L2-2.5.1.31 Equipment

Following equipment are to be provided,

NO	DESCRIPTION	QTY	REMARKS
1	Submersible pumps	4 Nos	
2	Lime preparation and dosing package plant (Pre lime)	1 No	
3	KMNO ₄ preparation and dosing package plant (Pre chlorine)	1 No.	
4	Lime preparation and dosing package plant (Pre lime)	1 No.	
5	FeCl preparation and dosing package plant	1 No.	
6	Filter control MOV (complete set)	8 Nos.	
7	Backwash pumps		
8	Backwash blowers		
9	Lime preparation and dosing package plant (Post lime)	1 No	

10	KMNO ₄ preparation and dosing package plant (Post CI-1)	1 No.	
11	KMNO ₄ preparation and dosing package plant (Post CI-2)	1 No.	

L2-2.5.1.32 Instrumentation, control and automation ((ICA) panel and SCADA system

ICA panel shall be provided for the control of the plant. This ICA panel is to be integrated to the new SCADA system installed in new pump station. Details are indicated under new pump station.

Instruments

Following instruments shall be provided,

DESCRIPTION		REMARKS
Inlet flow meters- 4 Nos.	EM Type	EM type for each inlet pipe to distribution chamber
Level transmitter- 1 No.	Ultrasonic	Distribution chamber level measurement
Level switch	Float type	Pump dry run protection at MCC
Level transmitter- 8 Nos	Ultrasonic	Filter water level measurement
Level transmitter - 1No.		Main reservoir
Water quality measurement		Existing clear water tank level measurement
RCL		
Turbidity		
pH		
Outlet flow meter on outlet to existing pump station	Electromagnetic	
Outlet flow meter on outlet to new pump station	Electromagnetic	

L2-2.5.1.33 Motor Control Centre (MCC), Local Operation Station (LOS), Local Control Panel (LCP) Etc

Following electrical equipment are to be provided,

Description	Remarks
Motor control Center (MCC)	Power distribution, common control and MOV and pump control. VFD control for submersible pumps
Filter control panel	Filter control panels for automation of filter operation and washing.
Local Control Panel for 04 Nos. submersible pumps	

Description	Remarks
Local operation station	Operation of equipment at close proximity for maintenance / under emergency conditions

L2-2.5.1.34 Control Philosophy

Submersible pumps in distribution chamber.

When remote operation is selected from MCC the pump control shall be from ICA Panel / SCADA. ICA Panel shall start / stop and speed control to maintain constant level in the distribution chamber.

Chemical dosing

Chemical dosing shall be controlled by chemical preparation and dosing packages. The Operator shall enter the required dosing rate corresponding to maximum flow in ICA / SCADA and the dosing rate shall proportionally adjust according to the water flow rate automatically.

Rapid Sand Filters

Each filter shall be operated and backwashed automatically by the filter control panel. Each filter control panel shall have dedicated PLC for this purpose. Following modes shall be available for filter back washing,

- Manual backwashing by operating the filter control valves and backwash pump / blower with push buttons from the filter control panel. (This operation shall be independent of the PLC.
- Semi auto wash initiation- by operator with push button
- Auto washing- from ICA / SCADA based on filter water level
- Auto washing from ICA / SCADA based on maximum elapsed time

Interlocking of filter washing shall be implemented to ensure sufficient backwash water, sufficient remaining capacity in sludge tank, no other filter is being washed.

Contractor shall prepare complete drawings / narrative description for approval.

L2-2.6 Work Section 4: Other Services

L2-2.6.1 Testing and Commissioning Services

System commissioning services shall conform to the Conditions of Contract.

The Contractor shall submit to the Construction Supervision Consultant for approval a programme for testing, up to the Taking-Over Certificate, at least 28 days in advance of the proposed start date of testing and shall agree on the timing not less than one week before the start of testing. The Contractor is required to prepare test record sheets for recording all test results, for the approval of the Construction Supervision Consultant, at least one month before tests are programmed to commence.

As soon as the Construction Supervision Consultant is satisfied that the installation of pump stations has been substantially completed, the Contractor can request to commence testing at site. Individual tests on all items of Plant shall be in accordance with the Employer's Requirements, and shall also be in accordance with the requirements of the applicable Reference Standards.

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During the stages of the testing and trial operation of the Works, the Contractor is responsible for all work, plant, temporary arrangements, fuel, electricity, water, qualified testing staff and all other costs in connection with the testing of the Works.

During the stages of testing, no water shall be put into supply network except with the prior authorisation of both the Construction Supervision Consultant and Employer.

All instruments used for testing purposes shall have been calibrated by an independent accredited testing authority and shall have a valid calibration certificate dated not exceeding 3-months prior. The Contractor shall satisfy the Construction Supervision Consultant as to the manufacturer's certified accuracy of all the instruments used for the tests, or otherwise have them calibrated at his own expense by an independent authority.

Test Certificates

Test certificates shall be provided giving a detailed record of all electrical and mechanical tests carried out on the equipment and material including lifting equipment, tanks, pumps, blowers, pressure vessels, pipes, fittings, cables, etc. both in the manufacturer's facilities and at Site.

Copies of certificates of all manufacturer's hydraulics tests as required by the applicable international standard for pumps, valves, pipes and pipe fittings shall be provided.

The Contractor shall obtain and submit to the Construction Supervision Consultant and to other parties as may be directed, within two weeks of completion of any witnessed tests, test certificates and curves of all items certifying that they have been satisfactorily tested and describing and giving full particulars of such tests.

Copies of test certificates of items of M&E equipment shall be included in the Operating and Maintenance Manuals.

Works Hydraulic Tests

All equipment subject to water pressure including pressure vessels, pumps, pipes, fittings and valves, shall be hydraulically tested to the test pressure where specified or to at least 1,5 times the maximum working pressure.

Inspection, Test and Guarantees

Schedules shall be prepared for the items by the Tenderer with Guaranteed Particulars and efficiencies of the equipment offered at the duties specified, and these will be binding and may not be varied except with the consent in writing of the Construction Supervision Consultant.

In accordance with the relevant international standards, all items of equipment shall be temporarily erected at the manufacturer's works, tested for satisfactory operation and offered for inspection. Certified copies of the manufacturer's test readings shall be submitted to the Construction Supervision Consultant prior to packing for shipment. Such inspection, examination, or testing, shall not release the Contractor, manufacturer or supplier of any item from any obligation. The Construction Supervision Consultant may request witness testing for certain major items at the manufacturer's facilities.

Additional Test Requirements for Pumps and Blowers

In addition to testing standards carried out in accordance with the ISO, DIN or other international standards specified herein, each pump (duty flow greater than 15 l / s) shall be tested as an integral unit for a flow capacity of 50%, 100% and 110% of the rated flow capacities (duty flow-rate). The tests shall include efficiency curves for the above flow capacities - both for the motors and for the pumps. Curves for motors may be based on the motor supplier's efficiency ratings.

Each blower shall be tested as an integral unit for a complete sequence of operation for a capacity of 100 % and just below the opening of the relief valve. The witness test shall obtain the guarantees of performance for each item of equipment.

For all lifting equipment and hoists, each installation inclusive of rails and beams shall be tested on site with test loads, provided by the Contractor, to demonstrate that the whole arrangement is capable of satisfactorily lifting 25 per cent above its rated load (lift in centre of gantry where applicable) and certificates of site tests shall be provided.

Individual Tests

Individual tests shall be carried out in the presence of the Construction Supervision Consultant and shall include at least the following tests which shall conform to the Employer's Requirements:

- Concrete Tests, as specified;
- Leakage tests for pipework and tanks, as specified;
- Electrical tests to demonstrate compliance of all electrical installation with specified and statutory requirements;
- Operational test for all valves;
- Running test for all pumps, blowers, compressors, all mechanical equipment, etc;
- Noise and vibration level measurement on all rotating equipment;
- Disinfection, as specified.

All individual tests of plant and equipment shall be completed, as per the relevant General Specifications, before starting the commissioning tests.

Commissioning Tests

Commissioning tests on the complete system shall be carried out by the Contractor to demonstrate to the Construction Supervision Consultant that substantial portions of the Works are ready to undergo trial operation with a minimum of interruption in regular operation. The Contractor shall provide his programme of commissioning including proposed sequence of opening and closing of valves, start-up of plant, etc., which is to be carried out in cooperation with the CWASA operators. The relevant operations personnel of the CWASA shall be present for the commissioning.

Two (2) complete draft copies of the O&M manuals are to be submitted to the Construction Supervision Consultant at least one (1) month before commencement of any commissioning tests. A third copy of the draft manual is to be provided by the Contractor for use by the operating staff during commissioning.

The period of the commissioning shall finish after the Works have been satisfactorily operated by the Contractor for a continuous period of fourteen (14) days or for such extended period required due to interruptions.

Trial Operation

The Contractor shall start and run the trial operation during the commissioning period, when the following conditions have been met:

- Pre-commissioning tests have been successfully completed;
- The associated facility (e.g. pump station) is ready;
- Draft O&M manuals have been submitted; and
- The Employer's staff has received full training as required.

In addition, certain tests to demonstrate compliance with specified performance of particular items of Plant or parts of the Works shall be carried out independently from the trial operation. These independent tests are also a condition prerequisite to the issue of the Taking-Over Certificate by the Construction Supervision Consultant.

The trial operation is to demonstrate that the Works can fulfil all mechanical, electrical, instrumentation, control and automation and process requirements of the relevant Specifications.

The Works shall be tested for a continuous period of fourteen (14) days, of which at least seven (7) days shall be uninterrupted by other tests. The objective of the tests is to start-up, monitor, adjust and obtain a comprehensive set of data to show that Plant performance meets the relevant Specifications and Employer's Requirements within the design capacities.

The Contractor is responsible for collecting and collating all data and test results, and preparing a report comprising test data, results, calculations and conclusions, which shall be submitted by the Contractor to the Construction Supervision Consultant within one (1) week of the date of completion of these tests.

L2-2.6.2 Operations And Maintenance (O&M) Manuals

Six (6) sets of the final O&M manuals, incorporating the comments from the Construction Supervision Consultant, are to be submitted by the Contractor no later than three (3) months after the issue of the Taking-Over Certificate (c / w two (2) sets of CD ROM discs and HTML format to be loaded onto the Works SCADA system).

Compilation of the O&M manuals shall comply with the Specification requirements and generally comply with the recommendations of BS 4884, Parts 1 and 2 (Technical Manuals – Content and Presentation).

The manuals shall be in English language, shall be securely bound, and pages shall be size A4 or folded to that size in a loose leaved hardcover binder, using not more than 70% of the binder capacity. Drawings shall be provided with a punched reinforced binder tab. No torn literature will be accepted.

The manuals must include for all items of equipment the manufacturer's recommended maintenance schedules, with instructions as to how the equipment is dismantled and reassembled for specified periodic corrective and preventative inspection and maintenance, and instructions for start / run / stop operation. Manuals shall enclose relevant technical information and data sheets for operating characteristics at ranges of loads, physical

dimensions and material specifications, wiring diagrams, etc. Manuals shall include a recommended list of spare parts and necessary consumables (lubricants, etc.).

Safety provisions for each maintenance process or operation shall be provided for each equipment or process, including post-accident procedures, and prevention recommendations. Safety equipment necessary shall be provided on-site.

Each volume of the manual shall be identified both on the front cover and on the spine, with the typed or printed title "OPERATIONS AND MAINTENANCE INSTRUCTIONS", with the title of the project, including the contract reference number, and the identity of the general subject matter covered in the manual. The text and drawings shall be placed in commercial 4-ring binders. The front cover and spine shall also bear the Employer's logo, details of which shall be provided by the Construction Supervision Consultant. The background of the cover shall be proposed by the Contractor and agreed with the Construction Supervision Consultant.

Only that manufacturer's printed data which is pertinent to the specific plant shall be included. Each sheet of manufacturer's instruction shall be annotated to identify clearly the specific item or plant installed and the instructions applicable to that item of plant.

The manual shall be prepared by skilled technical writers and shall be user friendly.

L2-2.6.3 Training

Tenderers are required to submit Training Programmes in their Tenders, which shall describe in detail all aspects of training to be provided under this Contract. Such training shall be subject to the requirements and approval of the Construction Supervision Consultant. Training of the Employer's personnel shall cover the operation and maintenance of all plant and equipment supplied under the contract. The number of persons to be trained shall be not less than 20 and approved by the Construction Supervision Consultant.

Training shall comprise the following aspects:

- Minimum 20 days of theoretical and practical training (training workshops)
- Minimum of 2-months on-work training to each staff; and
- Hands-On training with the Employer's O&M staff operating the systems and carrying out routine maintenance under the direction and supervision of the Contractor during the first three (3) months of the Defects Liability Period (DLP).

Theoretical and practical training shall start at an appropriate time during the construction and installation of plant and completed prior to the issue of the Taking-Over Certificate. Following the Theoretical and practical training, the Contractor shall provide 'hands-on' training and full direction and supervision until the end of the 3-month period at the start of the Defects Liability Period (DLP).

The Contractor shall provide an experienced training manager (with a minimum of ten (10) years training experience) to organize and supervise the training programme, who shall be on site during the first 3-month phase of the DLP.

Training shall be provided on site and at the Employer's premises, and shall commence at such time as directed by the Construction Supervision Consultant.

During installation of the plant, the Contractor shall provide videos illustrating all essential aspects of plant installation and testing for use in training.

Three training updates and assessment stages shall be carried out by the Contractor (a) at the completion of the 3-month period of O&M by the Contractor, (b) at 6-month intervals from the start of the DLP and (c) at the end of the DLP.

L2-2.6.4 DEFECTS LIABILITY PERIOD

The defects liability period commences on substantial completion of the works, or a part of the works as provided for under the contract, and after issue of the Taking-Over Certificate. A Taking-Over certificate shall only be provided if all testing stages have been satisfactorily passed, classroom training is complete, O&M manuals are complete subject to comments by the Construction Supervision Consultant, and the Contractor provides a written undertaking to finish with due expedition any outstanding tasks (and defects listed by the Construction Supervision Consultant) during the DLP.

During the first three (3) months after the Taking-Over Certificate has been issued, the Contractor is responsible for:

- Rectifying defects identified at the taking over
- Supply of all spare parts required for maintenance of plant; and
- Carrying out amendments to the O&M Manuals.

After this 3-month period and for the remainder of the Defects Liability Period, the Contractor is responsible for the following:

- Advising on operations of the whole of the Works by the Employer's personnel, including the provision of necessary skilled advisory staff and providing necessary training;
- Further training, if required, of the Employer's staff for O&M;
- Finding and rectifying defects in accordance with the Contract; and
- Carrying out amendments to the O&M manuals based on experience gained of the Employer operating the Plant.

Maintenance period of any DMA may be continued during the Defect notification period.

On the 6th and 11th months after the commencement of the Defects Liability Period, a competent engineer or other specialist representative of the Contractor shall visit the installation to inspect all plant provided, ensure that servicing, adjustments and recalibrations as necessary are being carried out and assess the competence of the Employer's personnel. This person shall be different than the person who provides the training described above. A full service report is to be provided by the Contractor within fourteen (14) days after each visit

L2-2.7 Performance Requirements

L2-2.7.1 General

This sub-clause sets out:

- (a) The preconditions to the Tests on Completion;
- (b) The minimum level of the functional guarantees; and
- (c) The formula for calculation of damages for failure to attain the functional guarantees.

L2-2.7.2 Preconditions to Tests on Completion

The Contractor gives the functional guarantees (as specified herein) for the facilities, subject to the following preconditions being fully satisfied for each work section:

L1-2.7.2.1 Section 1

- (a) Work Section 1, as defined by the Employer's Requirements, has been operated by the Contractor for a minimum period of fourteen (14) days;
- (b) All 28 DMAs within the Work Section 2 are established and DMA flow meters and pressure transducers are in operation.
- (c) The related plant and equipment of the Employer are in fully operating condition; and
- (d) The Employer supplies adequate treated water for system to provide a continuous water supply for commissioning the DMAs.

L1-2.7.2.2 Section 2

- (a) Work Section 1 and 2, as defined by the Employer's Requirements, has been operated by the Contractor for a minimum period of fourteen 14 days;
- (b) The related plant and equipment of the Employer are in fully operating condition; and
- (c) The Employer supplies adequate treated water for system to provide a continuous water supply for commissioning the works.
and
- (d) Successful completion of zero-pressure test and 7-day baseline assessment

L1-2.7.2.3 Section 3

- (a) Work Section 3, as defined by the Employer's Requirements, has been operated by the Contractor for a minimum period of fourteen 14 days;
- (b) The related plant and equipment of the Employer are in fully operating condition;

L2-2.7.3 Functional Guarantee Tests (Tests on Completion)

Following are applicable functional tests in general:

- a) The Contractor shall guarantee that the equipment offered shall meet the ratings and performance requirements stipulated for various equipment covered in these specification
- b) The Contractor shall conduct performance tests and demonstrate all the guarantees covered for each test. The guarantee tests shall be conducted by the Contractor at site in presence of Employer and the Construction Supervision Consultant on each unit individually.
- c) All costs associated with the tests including cost associated with the supply, calibration, installation and removal of the test instrumentation shall be included in the contract price.
- d) Within 7 days after the successful completion of each and every Performance test, the Contractor shall submit the test evaluation report of Performance test results to Employer and the Construction Supervision Consultant.

L1-2.7.3.1 Functional Guarantee for Section 1

The Contractor shall warrant following under this section;

1. Over a minimum of 14-day period, the functional guarantee test ensures that the minimum pressure at the DMA inlet point is equal to or greater than the minimum pressure in the approved contractors' hydraulic model, and the summation of the DMA inlet flows exceeds 95% of the measured volume at the Mohara delivery flowmeter.
2. The functional guarantee test for each pumping set, conducted over a minimum of 14-day period, ensures that the hydraulic energy output, calculated based on measured delivery pressure and delivery flowrate at the delivery manifold in 15-minute intervals, exceeds 80% of the measured electrical energy input obtained from the meter readings at the beginning and end of the period at the MCC energy meter.
3. The control system of each pump station, as per the Employer's Requirements, will meet the criteria for speed of response, data loading capacity, accuracy, and functionality, ensuring functional reliability, operational security, and maintainability. Additionally, it will be designed to prevent complete system failure resulting from single component failures.

L1-2.7.3.2 Functional Guarantee for Section 2

The Contractor shall warrant following under this section;

1. All DMAs must successfully meet the following criteria for a continuous minimum period of 14 days, subject to the acceptance of section 1: the minimum pressure at the DMA Critical Point must exceed 1 bar for at least 96% of the duration, and the total consumption of customers within each DMA, measured as the difference between their meter readings at the beginning and end of the period, must exceed 90% of the measured volume of water entering the DMA at the DMA meter(s) over the same period.

L1-2.7.3.3 Functional Guarantee for Section 3

When the water treatment works of Work Section 3 are operated in accordance with the Contractor's written instructions for minimum of 14 consecutive days, the Contractor shall warrant following;

1. Water treatment works will be capable of continuously producing Minimum 67 MLD of treated water as net production, while complying with the requirements for treated water quality, filter run-time and backwash water consumption, as specified in the Employer's Requirements.
2. While Water treatment works operates at 67 MLD as net production, the continuous quality of the treated water will be equal to or better than the quality specified in the Employer's Requirements.
3. While Water treatment works operates at 67 MLD as net production, the Contractor shall warrant that the minimum length of filter run between two consecutive backwashes will be 24 hours.
4. While Water treatment works operates at 67 MLD as net production, backwash water consumption averaged over the specified trial operation period will not exceed 5% (five percent) of the net water production over the same period.

5. The control system, as per the Employer's Requirements, will meet the criteria for speed of response, data loading capacity, accuracy, and functionality, ensuring functional reliability, operational security, and maintainability. Additionally, it will be designed to prevent complete system failure resulting from single component failures.

L2-3 SITE INFORMATION

L2-3.1 Topographic survey

As per the provided Spot Levels of the Project Area, Sector 1, Sector 4 and Sector 5 consist mostly of low-lying areas which are bordering the coast and the right bank of the lower reaches of the Karnaphuli river. The Spot Levels were used to produce contours for the network model and also to produce longitudinal sections and relevant drawings.

L2-3.2 Environmental and social baseline data

With a population of some 165 million people, Bangladesh is the world's tenth most densely populated country, and Chattogram, formerly Chittagong, is its second largest city. It covers the space between the coastline and the right banks of the Halda and Karnaphuli rivers, and is situated in the Southeast of the country and bounded in the West & South by the Bay of Bengal, Tripura State of India to the North, and East by the right banks of the river Karnaphuli & its tributary, the river Halda. Located between $20^{\circ} 35'$ & $22^{\circ} 59'$ North and between $91^{\circ} 27'$ & $92^{\circ} 22'$ East, the geography of Greater Chattogram is highly varied, with hills, forests, valleys, rivers and the ocean.

The country's first Export Processing Zone was established in Chattogram. The City has Bangladesh's largest seaport, is a major trade centre in South Asia and a main industrial centre for the country. The city has grown rapidly since the country's independence in 1971, but especially over the last three decades as a result of the country's economic growth. This rapid industrial development, particularly in the garment industry, resulted in inward rapid migration from the countryside, a process still ongoing today.

L2-3.3 Ground Investigation Data

Soil investigation has been done at one location on pumps station land plot at Kalurghat IRP premises and detailed report is given in Schedule xx.

L2-3.4 Land Ownership Information

CWASA is the authorized body for the ownership of the land areas of existing Mohara, Modunaghat, Karnaphuli, Bhandaljuri and Kalurghat WTP's as well as the Dhaka Trunk (DT), Patenga, Khulshi booster stations and the lands of ADC Hill, Nasirabad, Battali Hill and Haliashahar reservoirs. The Chattogram City Corporation and Roads & Highway department is the authorized body for the road network which is basically the laying area of the pipe network.

L2-3.5 Ground Water, Surface Water and Hydrological Information

L2-3.5.1 Ground water

Many households, businesses and communities in Chattogram rely on deep tube wells for their water, resulting in ground water level depletion because of over abstraction caused by large and constantly increasing population. As per JICA's Preparatory Survey Report on KWSP-2, March 2013, 32 deep tube wells were operated in Maintenance and Operation Division 1

(MOD-1) and 39 deep tube wells were operated in MOD-2 as of May 2012. Further, the report stated that a further 14 tube wells were newly added to the system. According to the CWSIP Sanitation Master Plan 2017, there were 40 in MOD-1 and 55 in MOD-2. This indicates that there were 95 tube wells in operation by 2017. This shows that the currently available total number of deep tube wells would be more than 100, though the exact number of boreholes currently in operation and good condition fluctuates.

L2-3.5.2 Surface Water

The Karnaphuli and Halda rivers are the existing surface water sources for Chattogram city. Of these, the main source of fresh water source for the city and its surrounding area is the Karnaphuli river, which is 270 km long, one of the longest in the south-east of Bangladesh. It originates in the eastern hilly areas and empties into the Bengal Bay, forming the southeast rim of Chattogram City. Its flow is controlled by the Kaptai Dam, some 40km upstream of the city, with an upstream lake of 680 km², which is the largest in the country. The dam is used for hydropower. The 98km long Halda river originates in the Chittagong Hill Tracts, near the Indian border, joining the Karnaphuli river about 17 km from the Karnaphuli River mouth.

L2-3.5.3 Hydrological Information

Chattogram has a humid, warm climate influenced by heavy rainfall during the monsoon, generally between May and June, with, as indicated in the Table 10 below, the highest temperatures just before and at the start of the monsoon.

Table 18: Typical climate data for Chattogram from 1981 to 2010 (ref: Wikipedia)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average high (°C)	26.0	28.3	30.8	31.9	32.4	31.7	31	31.4	31.8	31.7	30.0	27.2
Average low (°C)	14.0	16.3	20.5	23.6	24.9	25.4	25.2	25.3	25.2	24.1	20.3	15.8
Precipitation (mm)	7.3	25.0	55.5	136.4	314.0	591.3	735.6	513.9	239.3	197.8	59.5	14.1
Humidity (%)	73	70	74	77	79	83	85	85	83	81	78	75

With a yearly average of 2,900mm of rainfall, Chattogram typically receives well above the Bangladesh yearly average of 2,200mm. Rainfall is driven by the Southwest monsoon originating over the Indian Ocean and carries warm, moist, and unstable wind conditions. Typically, a tropical cyclone, of strength classification Tropical Storm or above, will make landfall in Bangladesh once in every two to three years bringing with it heavy rainfall, very high wind speeds, and storm surges from the sea.

Chattogram is susceptible to these climate impacts as it lies at the confluence of the river Karnaphuli and the Bay of Bengal, which itself is often exposed to these storm cyclones from the Indian Ocean. Before the Kaptai Dam was constructed in the 1950s, simultaneous monsoon flooding from the river and cyclone storm surges would cause rapid and uncontrollable floods.

As built records of existing infrastructure

1. Available Pipe laying drawings of CWSIP/W3, CWSIP/W4, CWSIP/W5, CWSIP/W8 contracts.



2. ADC hill – Site layout, General arrangements, Roof drainages, Pipework layout, Reinforcement details, Inlet control pipework, Chambers, Cross section, Drainage system
3. DT booster – Site layout
4. Kalurghat – General drawing, Filter RF details, Sedimentation basin effluent-filter influent, Filter sections, Rapid sand filter, Site layout, Yard piping, Filter reinforcement details, Site cross sections, Field collector
5. Kalurghat DTW- Layout, Pump house details, pipe laying, Tube well details
6. Other – Existing Street hydrants



L2-4 CONTRACTOR'S REPRESENTATIVE AND KEY PERSONNEL

Item No	Position / Specialization	Relevant Academic Qualifications	Experience
Applicable for Both Design and Construction			
1.	Contractor's Representative (01)	Bachelor Degree in Civil / Electrical / Mechanical Engineering from recognized Technical / Engineering University.	General experience: Minimum 20 (Twenty) years of professional experience in water supply projects, with a minimum 10 years as Project Manager of construction projects Specific Experience: Working as a Contractor's Representative At least 02 (Two) construction projects of water supply pipelines, water retaining structures and related activities.
2.	Cyber Security Expert (01)	Bachelor degree (or equivalent) in Computer Science and Engineering/ Information Systems/ Information Technology or related field from recognized University.	General experience: Minimum of 15 (Fifteen) years professional experience as an IT / Software Engineer. Specific Experience: Minimum 08 (Eight) years of experience as a Cyber Security Expert having experience in Cyber Security risk assessments on present potential or actual cyber security risks and knowledge in relevant Cyber Security Standards.
3.	Sexual Exploitation, Abuse and Harassment Expert (01)	Bachelor Degree in Social Science/related field from recognized University.	General experience: Minimum of 15 (Fifteen) years of professional experience as Social Expert Specific Experience: Minimum 08 (Eight) years of experience as a Sexual Exploitation, Abuse and Harassment Expert of Infrastructure Development Construction Project in a developing country with experience of monitoring and managing risks related to gender-based violence and relevant

Item No	Position / Specialization	Relevant Academic Qualifications	Experience
			experience in addressing issues related to sexual exploitation, sexual abuse and sexual harassment.
Key Personnel for Design			
1.	Lead Design Manager (01)	Bachelor degree in Civil / Engineering from recognized University.	General experience: Minimum 20 (Twenty) years of professional experience in water supply projects, with a minimum 10 years as Design Engineer of water supply projects Specific Experience: Working as a Lead Design Manager / Team Leader for at least 02 (Two) Projects in design of a Water Treatment Plant/ Water Supply Network/Pump station etc.
2.	Water Pipeline Network & Hydraulics Design Engineer (01)	Bachelor Degree in Civil Engineering / Mechanical / Hydraulics Engineering from recognized University.	General experience: Minimum 20 (Twenty) years of professional experience in water supply projects, with minimum 10 years as Water Pipeline Network/ Hydraulic Engineer of water supply projects. Specific Experience: Working as a Water Pipeline Network/ Hydraulics Engineer for at least 02 (Two) Projects for design of Water Supply Network with NRW reduction activities including DMA design and pressure management modeling.
3.	Environmental Specialist (01)	Bachelor Degree in Environmental Engineering/ Science	General experience: Minimum 10 (Ten) years of professional experience in assessment and management of environmental risk in development project. Specific Experience: Minimum 08 (Eight) years of experience in assessment and management of environmental risk in Infrastructure Design / Construction Project.
4.	Social Impact	Masters Degree in Social Sciences	General experience:

Item No	Position / Specialization	Relevant Academic Qualifications	Experience
	Assessment Specialist (01)		Minimum 10 (Ten) years of professional experience as Social Impact Assessment Specialist Specific Experience: Minimum 08 (Eight) years of experience as a Social Impact Assessment Specialist of Infrastructure Design/Construction Project.
5.	Health and Safety Specialist (01)	Bachelor degree in Engineering with Diploma in Occupational Safety & Health Certificate from a recognized Institution.	General experience: Minimum 15 (Fifteen) years of professional experience as Health and Safety Specialist. Specific Experience: Minimum 08 (Eight) years of experience as a Health and Safety Specialist of Infrastructure Construction Project.
Key Personnel for Construction			
1.	Construction Manager (Overall Construction Management) (01)	Bachelor Degree in Civil Engineering	General experience: Minimum 20 (Twenty) years of professional experience in of water supply projects, with a minimum 10 years as Construction Manager of water supply projects Specific Experience: Working as a Lead Construction Manager for at least 02 (Two) Water supply projects.
2.	Leakage Manager/ NRW Reduction Specialist (01)	Bachelor Degree in Civil / Mechanical Engineering.	General experience: Minimum 20 (Twenty) years of professional experience in water supply projects, with a minimum 10 years as Leakage Manager/ NRW Reduction Specialist of water supply projects. Specific Experience: Working as a Leakage Manager/ NRW Reduction Specialist for at least 02 (Two) Projects having urban water supply system similar in size, complexity and operation.

Item No	Position / Specialization	Relevant Academic Qualifications	Experience
3	DMA and Pressure Management Specialist (1)	Bachelor Degree in Civil / Mechanical Engineering	General experience: Minimum 20 (Twenty) years of professional experience in water supply projects, with a minimum 10 years as a DMA specialist. Specific Experience Working as a DMA and Pressure Management Specialist for at least 02 (Two) Projects of creation and operation of DMA in urban water supply system similar in size and complexity.
5	Metering Specialist (1)	Bachelor Degree in Civil / Mechanical Engineering	General experience: Minimum 20 (Twenty) years of professional experience in of water supply projects Specific Experience Working as an Engineer for at least 02 (Two) Projects of introducing Smart water metering in urban water supply system similar in size and complexity like Chattogram.
6.	GIS Specialist (01)	Bachelor Degree in Engineering/URP/Geography/related field	General experience: Minimum 20 (Twenty) years of professional experience in water supply projects Specific Experience Working as a GIS Specialist for at least 02 (Two) Projects of urban water supply system similar in size and complexity like Chattogram.
7.	Environmental Specialist (01)	Bachelor Degree in Environmental Engineering/Management/Science	General experience: Minimum 15 (fifteen) years of professional experience in managing environmental risk of development projects. Specific Experience: Minimum 08 (Eight) years of experience in managing environmental risk of large

Item No	Position / Specialization	Relevant Academic Qualifications	Experience
			construction projects similar in size and complexity preferably in water supply projects.
8.	Social Specialist (01)	Masters Degree in Social Sciences/related field	General experience: Minimum 10 (Ten) years of professional experience as Social Impact Assessment Specialist Specific Experience: Minimum 08 (Eight) years of experience as a Social Impact Assessment Specialist of Infrastructure Design / Construction Project.
9.	Health and Safety Officer (02)	Bachelor degree in Engineering with Diploma in Occupational Safety & Health Certificate from a recognized Institution.	General experience: Minimum 15 (Fifteen) years of professional experience in managing Health and Safety risk of development projects. Specific Experience: Minimum 08 (Eight) years of experience in managing Health and Safety of Infrastructure Construction Project similar in size and complexity preferably in water supply project.
10.	Quality Control & Quality Assurance Manager (02)	Bachelor Degree in Civil Engineering	General experience: Minimum 20 (Twenty) years of professional experience as Quality Control & Quality Assurance Manager in infrastructure projects. Specific Experience: Working as a Quality Control & Quality Assurance Manager for at least 02 (Two) Projects of similar in size and complexity like Chattogram.

L2-5 SPECIFICATIONS

This section outlines general requirement, design requirements that the contractor must take into account for their detailed design, as well as specifications for materials, equipment, and civil, structural, and M&E (Mechanical & Electrical) works. The Contractor should refer to relevant international standards.

L2-5.1 General Requirement**L2-5.1.1 General Works****L2-5.1.1.1 Intent of Contract Documents**

It is the intent of the Contract Documents to quantify and qualify the execution and completion of all facets of the works, and it is to be understood that the Contractor shall be fully responsible for provision of all designers, labour, material, constructional plant and equipment, tools, transportation, necessary supplies and consumables, and all other items required to execute the Works in a satisfactory manner and in accordance with the provisions in the Contract Documents, whether or not such materials, contractor's plant and equipment, etc., and other items are specifically indicated in the Employer's Requirements or shown on the Drawings. The Conditions of Contract, Drawings and the Bills of Quantities, Rates and Unit Prices are to be read in conjunction with the Employer's Requirements and Specifications. Matters referred to, shown or described in any of the former are not considered to be repeated in the latter. Notwithstanding, the subdivision of the Employer's Requirements under different headings, every part of it shall be deemed supplementary to and complementary to every other part. All references made in the Employer's Requirements will be references to Clauses or sub-Clauses hereof, unless specified otherwise. The term "Specification" shall be synonymous with the term "Employer's Requirements".

L2-5.1.1.2 Programme of Works

The Tenderer shall submit his programme of works in the form of a bar-chart in English and according to the requirements set out in the Appendix to Tender. Tenderers shall include and show against a monthly chart the planned dates for commencement and completion of all major items of works, and include mobilisation and demobilisation, and include any times for customs clearances if necessary. The programme of works shall be deemed to have taken into account all factors, and including normal weather conditions, groundwater, geotechnical conditions, and other programmed works in the area. The maximum time for completion is as stated in the Appendix to Tender. The Programme shall be within the specified time limits, commencing from the date of acceptance of Tender. The proposed overall programme shall be binding upon the successful Tenderer of which the Tenderer shall base his price.

Supporting information such as method statements, activity descriptions, sequences of work and time estimates for each activity shall supplement the programme. Tenderers shall refer to Section III, Evaluation and Qualification Criteria, for the provision of method statements and equipment schedules.

The successful tenderer shall submit the Contractor's detailed programme of Works within the time stated in the Conditions of Contract and in accordance with the relevant Sub-Clause below, and shall be comprehensive and cover all portions of the work. During the works, the Contractor's programme of works may be subject to revisions with regards to certain items and sequences, as ordered and approved by the Construction Supervision Consultant, however compliance to the overall programme submitted with the Tender shall remain.

Notwithstanding the above, the Contractor shall proceed with the works in such a manner as directed by the Construction Supervision Consultant. The Construction Supervision Consultant shall be entitled to, at any time, direct the Contractor to proceed with a particular section of the work, regardless of the construction programme.

The construction programme of the Contractor shall accommodate the following specific requirements depicted hereinafter.

- (a). Access to any of the roads and highways by the Contractor for the purpose of executing the contract shall be subject to prior approval of the relevant roads authorities. Submission of a suitably prepared Programme of Works by the Contractor incorporating the entire work in each section of road, from trench excavation through to hydraulic pressure testing of pipelines, completion of backfilling to the satisfaction of the relevant road authority, temporary reinstatement of road surface and hand over to the roads authorities on completion for permanent reinstatement, etc. is a prerequisite for approval by the road authority. The Contractor shall limit the trench excavation in any one location to lengths as specified or approved, at any one time.
- (b). Equipment to be provided by the Contractor to facilitate effective supervision of the Works by the Construction Supervision Consultant, as specified, shall be in place prior to commencing any Permanent Works.

L2-5.1.1.3 Interchangeability of Standards

The applicable technical standard specifications for the works listed throughout these specifications are to be the latest available versions published by the relevant agencies. The Construction Supervision Consultant may accept certain materials meeting other internationally accepted standards for use in the Contract, provided they are of an equal or higher quality than the reference standards. The Contractor shall provide sufficient documentary evidence to substantiate that the standard of substituted material is better than or equal to that stipulated in the Employer's Requirements. The Construction Supervision Consultant shall have the right to accept or reject any proposal offered by the Contractor. The Contractor shall provide copies of all relevant standards in English to the Construction Supervision Consultant for reference and approval at no additional cost to the Employer Minimum Standard.

The Employer's Requirements, Employer's Drawings and other Contract Documents define a minimum standard required for materials, manufacture and workmanship. The Contractor shall include in his Tender the cost of any additional work or improvements in the quality of the work that he may consider necessary to unconditionally guarantee the performance of the completed works in conformity with the Contract. All such proposals shall be given in the form of an Annex, but there is no obligation on the part of the Employer to accept any of the proposals offered by the Contractor.

L2-5.1.1.4 Workmanship

The quality of the workmanship and materials shall be compatible with the latest version of BS / BS EN ISO 9000 Series Quality Assurance Standards.

The Contractor shall demonstrate that personnel used for specialist tasks are suitably qualified, such as for electrical work to be carried out by qualified electricians in accordance with local regulations, and welding carried out by qualified welders.

L2-5.1.1.5 Specifications to be kept on Site

The Contractor shall have a complete copy set of Contract Documents, including the Employer's Requirements, approved construction drawings, standard specifications or parts of specifications applicable to works on site at all times. Any document relevant to this Contract shall be made available upon demand by the Construction Supervision Consultant. Failure to have copies of these documents on site shall be considered an infraction to the Contract and any delays caused to the works as a result of this lapse shall be the responsibility of the Contractor.

L2-5.1.1.6 Pre-Construction Start-Up Meeting

Prior to the start of Permanent Works at site, a pre-construction meeting shall be held at a mutually agreed time and place, attended by representatives of the following:

- The Contractor, the Construction Supervision Consultant, the Employer and / or his representative (CWASA).
- Others as requested by the Contractor, the Employer or the Construction Supervision Consultant.

The Contractor shall submit to the Construction Supervision Consultant a proposal for each of the following at least seven days prior to this meeting for discussion:

- Site organization chart, key posts and curricula vitae of the key staff to be employed for this Contract on full time basis by the Contractor.
- Construction Programme (refer to Clause 1.3.1).
- Cash flow forecast.
- Detailed Method Statements for the Works.
- List of construction equipment proposed for the works including category, quantity, type and capacity.
- Proposal for location and size of the camps, offices, workshops and stores, etc.
- Proposal for temporary storage of pipes and fittings during the works.
- Computer system and software to be used in producing programme of works as well for monitoring and updating the progress and resources throughout the project.
- Details of normal working days and daily working hours to be five (5) days per week, eight (8) hours per day, or as agreed with the Construction Supervision Consultant.
- Form of Design Drawings for approval.
- Details of procurement of imported equipment and materials.
- Materials and other submittals for approval.
- Details of procurement of materials such as Ready Mix Concrete, structural steel, galvanising, mild steel sleeves, pipes and fittings, rock protection, cast iron covers, geotextile fabric, bedding sand, granular bedding materials, bitumen coatings, cement, concrete additives, aggregate, reinforcing steel, sand, water source, marker posts and all as required in the specifications and drawings.
- Draft format of monthly interim statement.
- Other details as required within the Employer's Requirements.
- The purpose of this meeting is to designate responsible personnel and establish a cordial working relationship among the concerned parties. Matters requiring co-ordination for smooth implementation of the works shall be discussed and procedures for handling such matters will be established. The agenda for the meeting shall include:
 - Programme of Works of the Contractor.
 - Proposed methods of work and site organisation of the Contractor.
 - Transmittal, review and distribution of submittals by the Contractor.
 - Processing applications for payment & payment procedures.

- Maintaining record documents.
- Critical works sequencing.
- Field instructions and variations.
- Quality Assurance and Quality Control of the Works.
- Use of office and storage areas, security, and the Employer's needs.
- Major procured items, deliveries and priorities.
- Storage / Collection procedure of pipe materials and fittings from designated depots.
- Contractor's assignments for safety and first aid.
- Co-ordination with other agencies.
- Any other relevant matters.

L2-5.1.1.7 Progress Meetings

The Construction Supervision Consultant shall schedule and hold regular progress meetings at least every two (2) weeks and at other times as required by the progress of the work to review the progress of the work, maintain co-ordination of efforts, discuss programme changes and resolve other associated problems which may develop. The Contractor shall inform of any foreseeable risks towards the future progress of the works. Further regular site meetings shall be conducted at any sub- projects at dates and intervals agreed with the Construction Supervision Consultant.

The Contractor and the Construction Supervision Consultant shall be represented at each Progress meeting. The Contractor may at his discretion request the attendance of representatives of his suppliers and manufacturers. The Construction Supervision Consultant shall preside at the meetings and shall provide for maintaining and distribution of the minutes.

L2-5.1.1.8 Site Administration

The Contractor shall be fully responsible for all areas of the site used by him in the performance of the works. He shall exert full control over the actions of all his employees and other persons with respect to the use and preservation of property and existing facilities, except such controls as may be specifically reserved to the Employer, Construction Supervision Consultant or others. The Contractor shall be solely responsible for the overall co-ordination of the Contract, and no direct formal communication between his Sub-Contractors and the Construction Supervision Consultant shall be allowed. The Contractor has the right to expel from the site all persons who have no purpose related to the Works or its inspection, or to operations related to dominant rights to the site, with the approval of the Construction Supervision Consultant.

L2-5.1.1.9 Requirements of Authorities and Agencies

The Contractor shall be responsible for full compliance with the requirements of all duly constituted Authorities and Agencies concerned with any or all of the work under this Contract. The Contractor shall give to the Construction Supervision Consultant copies of all written notices required by the authority and the responses given.

Specific requirements for dealing with authorities concerned with road, stream, river and railway crossings are included in these Requirements, but this shall not relieve the Contractor of his general obligations under this Clause. The Contractor shall have early discussions with these authorities as regards their requirements and procedures and may seek the assistance of the Employer where necessary to arrange such discussions.

L2-5.1.2 Control of Work**L2-5.1.2.1 Land for Construction Purposes****(1) Public Property**

It is the responsibility of the Contractor to give all notices and obtain all necessary information and all necessary permissions from the authorities, prior to commencing construction. In addition, it is the Contractor's responsibility to liaison with the Police Traffic Department, if required, to arrange any road closures or traffic diversions required to complete the works.

Permits or approvals for work to proceed shall be obtained by the Contractor from relevant agencies with assistance of the CWASA through the Construction Supervision Consultant. All works performed and all operations of the Contractor, his employees or sub-contractors within the limits of the public property shall conform to the requirements and be under the control (through the CWASA and Construction Supervision Consultant) of such agencies owning or having jurisdiction over and control of the right-of-way in each case. Those relevant agencies shall include but not be limited to the following: Chattogram City Corporation (CCC), Roads and Highways Department (RHD), Chattogram Development Authority (CDA), Department of Environment (DOE), District Administration etc.

Materials or equipment shall not be placed on the property until the relevant agency has agreed to the location to be used for storage. The locations and extents of the areas so used shall be within the property line directed by relevant agencies. The Contractor shall immediately move stored materials or equipment at his own cost, if any occasion arises or when requested by the relevant agency as instructed by the Construction Supervision Consultant.

The Contractor shall contact the utilities and other concerned agencies and obtain permissions prior to cutting or closing roads, streets or other traffic areas or excavating near underground utilities or above ground utilities.

(2) Private Property

Except for replacement of CWASA customer meters as authorized by CWASA, the Contractor shall not enter for any deliveries or occupy for any other purpose with men, tools, equipment, construction materials, or with materials excavated from any trench or pit in any private property outside the designated way-leaves without written permission from the owner and / or tenant of the property.

Whenever the way-leave is occupied by crops which will be damaged by construction operations, the Contractor shall notify the Construction Supervision Consultant and owner or tenant sufficiently in advance so that where possible the crops may be harvested before excavation or trenching is started. The Contractor shall be responsible for all damage outside of the way-leave and shall make satisfactory settlement at his own cost for the damage directly with the property owner and / or tenant involved. The Contractor shall prepare a Condition Report of the area likely to be affected by the works to be agreed with the owner / tenant and the Construction Supervision Consultant.

(3). Access to Private Property

When it is necessary to temporarily deny access to owners or tenants to their property or when any utility service connection has to be interrupted, the Contractor shall give written notice as prescribed herein or by the relevant Authority sufficiently in advance to enable the

affected persons to provide for their needs. Notices shall include appropriate information concerning the interruption and instructions on how to limit their inconvenience.

All tasks above shall be deemed covered by the Contractor generally within his rates and prices in the Bill of Quantities.

L2-5.1.2.2 Surveying and Setting Out

Basic horizontal and vertical control points shall be established by the Contractor. Temporary points shall be established by the Contractor and shall be used as datums for the works. All additional survey, layout and measurement work shall be performed by the Contractor as a part of the work without any additional cost to the Employer.

The Contractor shall provide qualified and experienced surveyors and instrument men, competent assistants and such instruments, tools, stakes and other materials required to complete the survey, set-out and measurement work. In addition, the Contractor shall furnish without charge, competent men from his force and such tools, survey equipment, stakes and other materials as the Construction Supervision Consultant and Construction Supervision Consultant's site staff may require in establishing or designating control points, in establishing construction easement boundaries, or in checking survey, layout, as-placed pipe levels, and measurement work performed by the Contractor.

The Contractor shall keep the Construction Supervision Consultant informed, with prior notice of at least seven (7) days, of the times and locations at which he wishes to commence works and excavation, so that horizontal and vertical control points may be checked by the Construction Supervision Consultant with minimum inconvenience and no delay to the works. The Contractor shall remove and reconstruct work to the satisfaction of the Construction Supervision Consultant, which may otherwise become improperly located due to control points not being checked by the Construction Supervision Consultant, with all costs borne by the Contractor.

L2-5.1.2.3 Customer Survey

The Contractor shall conduct a survey of all houses (properties) in the service area. Besides CWASA consumers, also all other properties (prospective consumers) to be surveyed and checked for type of their water supply and possible illegal connections. Content of the customer survey should be approved by the Design Review and Construction Supervision Consultant. The survey shall record any special features, such as sprinkler systems and other fire-fighting requirements, or connections to a tank or a pump that may increase or moderate the expected maximum flow rate and record the location, orientation, size, type and serial number of each existing meter, with photos, identifying the location of the meter and stop tap, if any, to within $\pm 1.0\text{m}$ in plan, using latitude and longitude, UTM coordinates and Uber H3 level 15 identifiers. The Contractor shall similarly record the same information for each new replacement service pipe and meter, with location and elevation relative to ground level at its location, $\pm 0.1\text{m}$, as soon as the new replacement service pipe has been installed and the existing service pipe is ready for decommissioning. Contractor shall communicate survey findings to the Package CWSIP/G3 Supplier through the Construction Supervision Consultant.

The Contractor shall use the survey findings to evaluate the minimum size of replacement meter required, the need for any spacers, adapters or special fittings needed for installation in place of the existing meter, and the suitability of the location for remote reading of the replacement meter, with or without an additional antenna.

As of August 2022, the CWASA billing system listed the numbers of existing meters of each size in Table 3.3-1

Table 3.3 – 1: Numbers of meters of each size in the CWASA billing system in August 2022

Meter Size	Numbers of Meters						Total
	Domestic			Non-Domestic			
	Gallon	Litre	sub-total	Gallon	Litre	sub-total	
0.75 INCH	209	69,907	70,116	29	4,137	4,166	74,282
1 INCH	17	4,551	4,568	12	941	953	5,521
2 INCH	23	103	126	8	155	163	289
4 INCH	1	49	50		23	23	73
6 INCH		6	6		5	5	11
8 INCH					2	2	2
Total	250	74,616	74,866	49	5,263	5,312	80,178

The total number of meters increases at a rate of approximately 5,000 per years so is expected to reach approximately 100,000 during the Contract Period.

L2-5.1.2.4 Construction Plant and Equipment

The Contractor shall mobilise adequate and appropriate construction plant and equipment with suitable type and capacity to secure a satisfactory quality of work and rate of progress, to ensure completion of the works within the time limit stipulated in the Contract. The Contractor shall also furnish to the Construction Supervision Consultant a list containing all construction plant and equipment that he intends to deploy at site(s) before commencement of work. All plant and equipment shall be equivalent or higher in capacities and numbers as specified in the Contract Documents or provided at the tender stage by the Contractor.

L2-5.1.2.5 Locations of Work

The structures, facilities and pipe works have been located as indicated on the Employer's indicative Drawings. The Construction Supervision Consultant reserves the right to modify locations, within the Conditions of the Contract, in order to avoid interference with existing structures or service utilities encountered, or for any other reason.

L2-5.1.2.6 Open Trench Safety

At end of works each day, trenches in roads shall not be left open overnight.

The construction of open trenches shall, at any one time, be limited to lengths previously approved by the Construction Supervision Consultant, in writing, depending on the particular surrounding conditions, and in accordance with the approved method statement. The maximum length of trench suggested for agreement for the works along narrow roads shall be 100 metres at any one site. Unless otherwise approved by the Construction Supervision Consultant in writing, work on each approved length(s) shall be practically completed to the satisfaction of the Construction Supervision Consultant before work on any new length is commenced. If the authorities permit the Contractor to temporarily close off to the public an entire street, then the length of open trench may be increased, as approved. However, the Contractor shall note his overall final responsibility towards safety protection around open trenches, and shall accept full responsibility for any related accident if such occurs.

To provide the public with the necessary safety and protection, the Contractor shall at his expense provide barricades, tapes, lights, warning signals and sign boards, guard rails,

pedestrian crossings over trenches, supervision and watchmen services to the satisfaction of the Construction Supervision Consultant and all other safety measures in accordance with local regulations and these General Requirements and other applicable sections of the Employer's Requirements. Costs for all safety measures shall be deemed covered by the Contractor in his Tender under the relevant item for provision of safety measures.

L2-5.1.2.7 Uncovering Work for Inspection & Correction of Defective Works

The Contractor shall perform all cutting, removal, patching and repairs required for the works as may be necessary in connection with uncovering of works for inspection purposes, or for the correction of defective works, or for the installation of improperly timed work, or for removing samples of installed materials for testing, at no extra cost to the Employer.

The Contractor shall not undertake any cutting or removal, which may affect the structural stability of the Work or existing facilities, without concurrence of the Construction Supervision Consultant.

L2-5.1.2.8 Protection of Existing Structures and Utilities

The Contractor shall provide all shoring, bracing, supports and protective devices as necessary to safeguard all works and existing facilities during excavation, construction, cutting, removal, patching or repair operations. Materials shall be cut and removed to the extent indicated on the Employer's Drawings or as required on-site with the approval of the Construction Supervision Consultant to complete the work. Materials shall be removed in a careful manner with no damage to adjacent facilities or materials. Materials which are not salvageable shall be disposed off-site by the Contractor.

All existing works or existing facilities affected by cutting, patching or construction operations shall be restored with new materials, or with salvaged materials acceptable to the Construction Supervision Consultant, to obtain a finished installation with the strength, appearance, and functional capacity which pre-existed the construction. If necessary, entire surfaces shall be redone and refinished.

The Contractor shall assume full responsibility at no additional cost to the Employer for the protection of all buildings, structures, natural embankments and utilities either public or private including poles, signs, services to buildings, service utilities, water pipes, hydrants, drains, electric and telephone ducts and conduits whether or not they are shown on the Employer's Drawings. The Contractor shall carefully support and protect all such structures and utilities from damage of any kind during or arising from the Contractor's activities under the Contract.

Prior to commencement of construction, the Contractor shall make further investigations, and contact the relevant authorities, if necessary, to determine and satisfy himself of the exact location and level of all services that may conflict with the design of the proposed works or are in the vicinity of the works, including any service not shown on the plans but which he or the Construction Supervision Consultant may believe to exist. Services found to conflict with the new works as detailed on the Drawings shall be notified to the Construction Supervision Consultant, who may consider amendment of the design as an alternative to permanent relocation of the existing utility. Early scrutiny of these services is essential to enable for such relocations to be prepared in advance of the construction. The Contractor shall contact the local officials of each of the statutory authorities responsible for buried services and shall maintain close liaison with them throughout the construction period.

These investigations shall comprise trial holes excavated at suitable intervals in a manner that will not damage the utilities, and location of surface indications of chambers, all without any

additional cost to the Employer. All such excavations shall either be protected until the general excavation meets this excavation or be re-filled after recording the nature and position of the service according to the Construction Supervision Consultant's instructions.

Thereafter, the Contractor shall assume full responsibility for all underground structures and service utilities, whether shown on the Employer's Drawings or not, and all such services shall be maintained uninterrupted during construction. The Employer accepts no responsibility whatsoever for any omissions from or for the incorrect representation on the Drawings of these existing services.

At least 5 days prior to commencement of work in the vicinity of the structures likely to be affected by the works, the Contractor shall prepare a Condition Report of adjacent structures to be agreed with the owner and the Construction Supervision Consultant, including photographs and shall advise the Construction Supervision Consultant of any services which interfere with the execution of the works and which require to be removed and relocated, who will determine the extent of the work, if any, to be undertaken by the Contractor in protecting or removing, relocating and reinstating such services and, on account of approval from the relevant authority, give written approval to the Contractor to proceed with the removal or deviation of such existing works.

Any work required to be undertaken by the Contractor in permanent relocation of services for which no provision is made, or for which no applicable tendered rates exist, will be paid for in accordance with the Conditions of Contract.

The Contractor shall take all reasonable precautions to prevent damage to existing buried main house service utilities and connections to buildings. When an existing house service connection is encountered during construction that conflicts with the construction of the Permanent Works, permanent works for its relocation shall be agreed in detail with the Construction Supervision Consultant. Drain and sewer permanent relocation works shall be made by the Contractor and other relocation works by the statutory authorities unless prior agreement is obtained from them for the work to be done by the Contractor.. Crossings of new pipelines across all existing house service connections to individual premises or properties shall be deemed to be included in the unit rates for pipeworks.

The Contractor shall in any case provide adequate temporary support to all existing services and connections that are exposed or partially exposed or otherwise weakened by the excavation. The Contractor shall immediately notify the Construction Supervision Consultant and relevant statutory authority and afford every facility for their quick repair when any damage occurs to a service. No separate payment shall be made to the Contractor for such repairs.

In addition to the precautions to be taken with buried services, the Contractor shall ensure that his plant and equipment do not damage pipeline or pipe supports above ground level or any electricity or telephone overhead cables. Adequate precautions shall also be taken to prevent his plant from operating too close to overhead high-tension cables and shall, in conjunction with the Construction Supervision Consultant and electricity authority, establish all necessary precautions for crossing under such cables. No mechanical excavation shall be permitted within 2 metres of the established positions of high voltage cables. If electric power lines must be diverted, the Contractor shall initiate such action prior to commencement of work through the agency concerned in liaison with the Construction Supervision Consultant.

The costs of searching and locating existing underground utilities, trial holes, protection of existing utilities and aboveground services, facilities and structures, and temporary removal

and reinstatement of existing utilities shall be deemed covered generally by the Contractor within his rates and prices for the works.

L2-5.1.2.9 Obstruction of Utility Services

The Contractor shall ensure that all existing fire hydrants, control valves and other utility controls shall remain unobstructed and readily accessible during the construction of the Works.

L2-5.1.2.10 Operation of Existing Utility Services

The Contractor shall obtain written approval from the authorities concerned before operating any valve, switch, or other control on any existing utility services. All consumers affected by such operation shall be notified by the Contractor in advance, the full detail of operation date, time and probable duration of service interruption. In case of drinking water supplies, the Contractor shall provide alternative arrangements to supply water (such as supply with water tanker) to the affected consumers without any extra charge to the Employer or Customer.

L2-5.1.2.11 Maintenance of Flow

The Contractor shall provide alternative arrangement for the flow of drains and water courses interrupted during the progress of the work and shall immediately remove all debris and detritus matter on completion. Costs of all such works shall be deemed to be covered generally overall within the Contractors rates and prices for the works. The full procedure of maintaining existing drainage flows shall be discussed with the Construction Supervision Consultant at least seven (7) days in advance to works.

L2-5.1.2.12 Provisions for Traffic and Detours

All construction activities and excavation shall be carried out in such a manner as to create a minimum of inconvenience and interference with pedestrian and vehicular traffic, and with access to buildings or other properties. The Contractor shall construct temporary bridging across his trenches where necessary, for traffic including access to private property and to pedestrians. All excavated material shall be stockpiled in a manner that will not endanger the work or the personnel engaged therein or third parties, be covered to prevent spreading, and will avoid obstructing sidewalks and driveways or lay on permanent structures. Hydrants, valve chamber covers, valve boxes, kerb stop boxes, fire and police call boxes or their utility controls shall be left unobstructed and accessible until the work is complete. All above shall be further in accordance with the details in the relevant Clauses of other parts of the Employer's Requirements.

The Contractor shall strive to limit temporary storage of backfill materials and disruption to traffic, for example by stockpiling the excavated material from an initial relatively short length of trench such that suitable excavated material from each subsequent short trench length may be used to backfill for the previous short trench length.

Roads shall not be closed unless permitted by the relevant road authority. Where detours are permitted, the Contractor shall provide all luminous barricades, red warning lights, and traffic signs required to divert the flow of traffic and shall expedite construction operations to minimise disruption. Costs for all such work shall be covered by the Contractor within his price for maintaining traffic flows.

L2-5.1.2.13 Sites of Works and Co-operation with other Contractors

Possession of sites for the booster pump station and reservoir M&E works shall be sought in time in accordance with the agreed programme of works and shall be coordinated with the several other Contractors.

The Contractor shall plan, schedule and co-ordinate his operations in a manner that will facilitate simultaneous progress of the work of other contractors working on roads, electricity, telecom, etc. implemented by other agencies. This contract shall be run concurrently with:

- Package CWSIP/W1, Lot 1 contract for the equivalent Works in Sectors 2 and 3
- Package CWSIP/G3 contract which is for supplying and installation of DMA & AMR meters,
- Package CWSIP/W2 and CWSIP/W3 contract which is for construction of Deep Tube Wells;

For the sites of works within reservoirs the Contractor shall make arrangements with the CWASA and plant operator regarding any required access to site. Requirements of the operator and security staff shall be taken into account at all times. The Contractor shall take particular care to protect any access roads and shall be responsible for remedial works for any damage caused by the Contractor's operations.

Any access to sites of reservoirs shall be allowed in accordance with the agreed programme of works, but shall be coordinated with the other Contractors.

L2-5.1.2.14 Surface Protection

The Contractor shall bear full responsibility for the protection of all finished exterior and interior surfaces, fixtures and equipment from stains, marks, dirt or damage of any kind, from the time of their construction, finishing or installation until the time of final handing over the fully completed works to the Employer.

Before requesting an inspection of the completed works with the intent of final acceptance, the Contractor shall do all necessary cleaning, making good and touching up that may be required to leave all finished surfaces, fixtures and equipment in acceptable condition in accordance with the full intent and meaning of these specifications.

L2-5.1.2.15 Flotation

The Contractor shall take all-necessary precautions against flotation of any structures or pipelines, particularly plastic pipes. The Contractor shall be fully responsible for any damage caused by flotation and for making good of such damage at no extra cost to the Employer.

L2-5.1.2.16 Inconvenience and Right of Access

The construction of the Works shall be carried out avoiding inconvenience as far as feasible to the owners and occupants of properties adjacent to the Works. Costs for any measures provided in this regard shall be borne by the Contractor.

L2-5.1.2.17 Preventive Measures against Water Supply Interruption

The Contractor shall ensure that he has stocks of repair materials at each works site location to enable immediate repairs, minimising interruption of water supply, in the event of accidental damage to existing utility services. Costs for such repairs shall be borne by the Contractor.

L2-5.1.2.18 Surplus Fill Material

The Contractor shall be responsible for making all arrangements for the disposal of all surplus material from any excavation, which is material extra over the selected excavated material needed for use in the backfilling, grading or other purpose, as shown in the Employer's Drawings, and for handling of this surplus material over the whole distance from the point of excavation to the point of disposal. Costs for such works shall be deemed covered by the Contractor within his rates for such works.

L2-5.1.2.19 Pumping and Drainage

The Contractor shall dispose of all groundwater and surface runoff to existing water courses with all measures needed to prevent excessive solid materials being discharged, all in a manner approved by the Construction Supervision Consultant. Costs for such works shall be deemed covered by the Contractor within his rates and prices for the works.

L2-5.1.2.20 Overhead Construction

No machinery shall be employed which, in the opinion of the Construction Supervision Consultant shall unduly interfere with wires and other overhead construction.

L2-5.1.2.21 Unfavourable Construction Conditions

At times during adverse weather conditions, special means or precautions shall be undertaken by the Contractor to the approval of the Construction Supervision Consultant so as to perform any work in a proper and satisfactory manner. No portion of the work shall be constructed under conditions, which would, in the opinion of the Construction Supervision Consultant, adversely affect the quality of works.

L2-5.1.2.22 Public Notice of Starting Work

The Contractor shall provide and distribute to all residents in the area which, may be affected by the work, a full page size printed notice in Bengali and English languages with wording similar to that shown in next page:

NOTICE

TO THE PEOPLE IN THIS AREA

WITHIN THE NEXT FEW DAYS, WORK WILL BE STARTED ON THE CONSTRUCTION OF NEW WATER SUPPLY FACILITIES.

This work may cause some inconvenience but will be of permanent benefit.

We shall appreciate your co-operation on the following matters:

1. Please be alert when driving or walking in or near the Construction area.
2. Tools, materials, and equipment are attractive to children. For the safety of the children, please keep children away from the work sites.
3. Please report all inconvenience to the Site Construction Supervision Consultant or call the office at the numbers given below:

Telephone Nos:

.....

The work is being performed to support the Chattogram Water and Sewerage Authority under the World Bank funding by:

(Insert Firm Name, Address, and Telephone Number of the Contractor in this space)

In case of any complaints, you may contact us on the above telephone.

We will endeavour to complete this work as rapidly as possible and with a minimum of inconvenience to you.

Date of Notice :

Signed :

Title :

L2-5.1.3 Submittals

L2-5.1.3.1 Construction Programme

The Contractor shall submit three (03) copies of his detailed construction programme within twenty-eight (28) days after the date of the Letter of Acceptance. The Contractor shall comply with the following aspects in the preparation and presentation of his programme:

- i. Use appropriate computer-based project management software approved by the Construction Supervision Consultant. The system used shall clearly show the Contractor's construction programme, resources, sites, procurement schedule, and cash-flow requirements; and during the course of the contract be capable of clearly showing progress compared to the original programme.
- ii. The construction programme submitted in a bar chart form shall show the start and finish dates of the principal preparatory and construction operations including mobilisation, approvals of materials and equipment, procurement and delivery of materials and equipment, construction and installation, testing, commissioning and hand-over.
- iii. A graph showing the build-up of staff and labour resources related to the tasks and work identified in the Construction Programme.
- iv. A schedule of major plant and their time on site related to the Construction Programme.
- v. A Critical Path Network (CPN) showing the optimum order of work, available time for each activity and effects of delays. The CPN shall be updated during the course of the Contract to show construction sequence changes that may arise together with the changes in resources needed to maintain the overall schedule for completion of the Contract on time.
- vi. Programming shall take into account:
 - The Notice to Commence Work
 - The periods for approval of the programme or subsequent revisions thereto
 - Permissions for access to road sites
 - Designs and approval of shop drawings

Approval of the programme and shop drawings shall not relieve the Contractor of any of his responsibilities under the Contract.

- vii. Three copies of programme revisions that become necessary during the course of the works shall be submitted to the Construction Supervision Consultant for approval of the details at least seven (7) days before the proposed revision is to be implemented. Three (3) copies of the revised programme as approved shall be supplied to the Construction Supervision Consultant within three (3) days of approval being given.
- viii. The programme of works shall be based on sub-programmes for each Works Section. The sub-programmes shall include all the principal tasks envisaged to be required for the proper execution for each Works Section.

In the case of pipe-laying in roads, the periods required for obtaining permission from the relevant authorities for entry into the roads and for the execution of the work until completion of testing and hand-over to the authorities for final reinstatement work shall be included. The Contractor shall be required to discuss the sub-programmes for each section of road with the Construction Supervision Consultant and the relevant roads authorities prior to starting work

and shall be expected to make such changes to the order of work as the authorities may impose.

L2-5.1.3.2 Progress of Works

(i). Contractor's Progress Reports

The Contractor shall submit Monthly and Quarterly Progress Reports to the Construction Supervision Consultant in quadruplicate at least seven (7) days prior to the date of monthly and quarterly progress meetings. The actual work done shall be superimposed upon the copies of the programme. Reports shall furnish an explanation of any deviation from the programme and shall state proposals for improving progress in the event of this be lacking in any respect. The reports shall show clearly and accurately the position of all activities associated with the works including mobilisation, manufacturing, delivery, site erection, installation, construction, testing and commissioning, etc. Reports shall inform of all problems and foreseen risks towards the progress of the works, together with suggested actions to resolve the issues.

(ii). Photographic Record

The Construction Supervision Consultant shall maintain the photographic record every month during the construction work. The Contractor shall submit a report in quadruplicate to the Construction Supervision Consultant with Photo Prints using a digital camera.

(iii) Progress Meetings.

Costs for all reports, Programme of Works and updates shall be covered by the Contractor generally within his rates and prices for the works.

L2-5.1.3.3 Survey Data

All field books, notes and other data developed by the Contractor in performing surveys required as part of the works shall be made available to the Construction Supervision Consultant for examination throughout the construction period. All such data shall be submitted to the Construction Supervision Consultant with the other documentation required for final acceptance of the work. The survey shall be done in the presence of the Construction Supervision Consultant where measurement for preparing monthly invoices is required.

L2-5.1.3.4 Shop Drawings and Engineering Data

All shop drawings regardless of origin shall be stamped bearing the approval of the Contractor and identified with the name and number of this Contract, Contractor's name, and references to applicable specification paragraphs and Contract drawings. Each submittal shall indicate the intended use of the item in the work. When catalogue pages are submitted, applicable items shall be clearly identified and printed brand name, manufacturer's name & address clearly visible. The current revision, issue number and / or date shall be indicated on all shop drawings and other descriptive data.

The Contractor's stamp of approval shall be representation to the Employer and the Construction Supervision Consultant that the Contractor has assumed full responsibility for determining and verifying all quantities, dimensions, field construction criteria, materials, catalogue numbers, and similar data, and that he has reviewed or co-ordinated each submittal with the requirements of the work and the Contract Documents. The Construction Supervision Consultant shall accept no shop drawing or other submittal from anyone but the Contractor. The Contractor shall be responsible for any submittals from his suppliers and manufacturers.

If required, the Construction Supervision Consultant, on Contractor's request, shall provide CAD or paper copies of the Employer's drawings. The Contractor shall verify all details and take full responsibility of all designs in the drawings. Any survey work required for the Contractor's design shall be carried out by an experienced engineering surveyor.

Engineering data covering all equipment and fabricated materials to be furnished under this Contract shall be submitted to the Construction Supervision Consultant for review. These data shall include drawings and descriptive information in sufficient detail to show the kind, size, arrangement, and operation of component materials and devices; the external connections, anchorage, and supports required; performance characteristics; and dimensions needed for installation and correlation with other materials and equipment and the standard for which the equipment or material is manufactured.

The Contractor shall in writing direct specific attention to revisions other than those called for by the Construction Supervision Consultant on previous submissions when corrected copies are resubmitted. Neither the work shall be performed in connection with the fabrication or manufacture of materials and equipment nor shall any accessory or appurtenance be purchased, until the shop drawings and data therein have been reviewed by the Construction Supervision Consultant. The Contractor's commencement of works is his own risk and responsibility.

The Construction Supervision Consultant shall be provided with four (4) copies of each shop drawing and necessary data initially. When the shop drawings and data [two (2) copies] are returned to the Contractor marked EXCEPTIONS NOTED, the corrections shall be made as noted thereon and as instructed by the Construction Supervision Consultant and not less than two (2) additional copies of all such shop drawings and data shall be furnished after final review. When the drawings and data are returned marked NO EXCEPTIONS NOTED, not less than two (2) additional copies shall be furnished.

The Construction Supervision Consultant's review of shop drawings and data submitted by the Contractor shall cover general conformity to the Employer's Drawings and Employer's Requirements, mistakes, contradiction, external connections, and dimensions which affect the layout. The Construction Supervision Consultant's review of shop drawings returned marked NO EXCEPTIONS NOTED or EXCEPTIONS NOTED does not indicate a thorough review of all dimensions, capacities, design strengths, design calculations, quantities, and details of the material, equipment, device, or items shown.

All shop drawings and data after final processing by the Construction Supervision Consultant shall become a part of the Contract Documents, and work shall conform to the shop drawings and data unless otherwise authorised by the Construction Supervision Consultant. Any need for re-submission, or any other delay in obtaining the Construction Supervision Consultant's review of submittals, shall not entitle the Contractor to extension of the Contract Period.

L2-5.1.3.5 "As-Built" Drawings

The Contractor shall submit one copy of the draft "As Built" drawings for Construction Supervision Consultant's approval as soon as each portion of work is completed. During construction, the Contractor shall maintain As-Built Drawings and records on site, which are available for inspection by the Construction Supervision Consultant at any time. The "As-Built" Drawings are required as a record of all work carried out. The Original "As-Built" drawings to be furnished in Drafting Film Paper, two negatives on sepia papers and two sets of photocopy prints. In these drawings, it is necessary to indicate "As-Built" conditions including field modifications and furnish additional paper copies for insertion in equipment



instruction books or operation and maintenance manuals as required. All such copies shall be clearly marked "AS-BUILT" and signed by the Contractor. Production of "As-Built" Drawings shall proceed in parallel with the construction work and shall be considered as part of the completed works. The Contractor shall be required to provide all As-Built Drawings, to be approved by the Construction Supervision Consultant, seven (7) days after testing of the works and prior issue of the Taking-Over Certificate.

The as-constructed information may be drafted over CAD copies of the contract drawings where possible, to equivalent standards of the contract drawings. The Construction Supervision Consultant, on Contractor's request, shall provide CAD or paper copies of the drawings. The drawings shall be stamped "As-Built" and be signed by the Contractor. Survey work shall be carried out by an experienced engineering surveyor.

As a minimum, information to be provided shall include, but not be limited to, all information from the Employer's Drawings or approved changes / additions, all information from the Contractor's Drawings, locations of all structures (lines and levels) and depths of foundations, earthworks final levels, extents of excavation, equipment and product materials installed, pipe and conduit locations (and invert level, diameter, material, class, connections, valves, flowmeters, gauges, etc.).

The "As-Built" Drawings shall be presented on A1 size (841mm x 594mm) sheets, arranged in sequential order along each pipeline. Lettering shall be sized and arranged to enable A3 size reductions to be legible. The Drafting Film shall be "Ozadraft drafting film 70" or equivalent quality approved by the Construction Supervision Consultant.

Payment for As-Built Drawings shall be covered under the respective item in the Bill of Quantities.

L2-5.1.3.6 Layout Data

The Contractor shall keep neat and legible notes of measurements and calculations made by him in connection with the layout of the work. Copies of such data shall be furnished to the Construction Supervision Consultant for use in checking the Contractor's layout as provided under Lines and Grades. All such data considered of value to the Employer shall be transmitted to the Employer by the Construction Supervision Consultant with other records upon completion of the work.

L2-5.1.3.7 Standards and Specifications

The Contractor shall provide the Construction Supervision Consultant with two sets of each standard and specification referred to in these Requirements concerning equipment, materials and workmanship in English language.

L2-5.1.3.8 Quality Assurance Plan

General

The Contractor shall submit a Quality Assurance Plan within twenty-one (21) days after the date of the Letter of Acceptance. The Quality Assurance Plan shall comply with a recognised international Quality Assurance Standard. The costs for the Quality Assurance Plan, monitoring tasks, audits and relevant documentation shall be deemed included generally within the Contractor's rates and prices.

The Construction Supervision Consultant will assess the Quality Assurance Plan and return it to the Contractor within 14 days of receipt, together with any comments, requirements or amendments for inclusion in the Quality Plan. The Construction Supervision Consultant will

continue to return to the Contractor within 14 days of receipt of the Contractor's Quality Assurance Plan until such time as the Construction Supervision Consultant approves the Quality Assurance Plan in writing. Any Contractor's delay in obtaining the approval of his Quality Assurance Plan by the Construction Supervision Consultant shall be at the Contractor's expense, and the Contractor shall not be entitled to any extension of time due to such delay unless the Construction Supervision Consultant has taken more than 14 days to reply to the Contractor's submission of the Quality Assurance Plan. The Contractor shall not commence the Works until the Construction Supervision Consultant has approved in writing the Contractor's Quality Assurance Plan.

The Quality Assurance Plan shall include, but not be limited to the following:

- (1) Inspection and test plans and procedures for all materials and construction work;
- (2) Non-conformance and defect identification and action procedures;
- (3) Details of Quality Control Personnel and relationships to the Contractor; and
- (4) Monitor scheduling of Contract activities such as design, fabrication, factory testing, procurement, shipment, shop drawings, site survey control, earthworks, formwork, reinforcement and concreting, piping, installations, siteworks, commissioning, and the like; and ongoing identification of critical activities;
- (5) Management and control of deviations, additions and variations to the Contract; and all other document control and distribution; and
- (6) The Contractor's Quality Assurance Plan shall also include the following:
 - (a) Such measures as are necessary to trace each product or service from receipt through construction, and
 - (b) Quality assurance and quality control procedures covering all material supply, fabrications off-site, manufacture, construction, and services carried out by the Contractor and any of his sub-contractors. Quality control tests and inspections for materials, plant, equipment, and workmanship shall be in accordance with the requirements in the Employer's Requirements and Conditions of Contract for all materials, plant, equipment and workmanship.

Procedures shall identify personnel suitably qualified to lead various parts of the works, and at least one representative shall be available at site. Procedures for each part of the works shall identify work practices to be used and typical plant and standby plant available at site.

Monitoring and Testing

The Contractor shall, throughout the duration of the Contract, carry out monitoring and testing in accordance with the approved Quality Assurance Plan. In the event of any non-conformance to the requirements of this specification, the Contractor shall immediately advise the Construction Supervision Consultant the details of such non-conformance, including location in the Works, and the proposed remedial actions.

Construction Supervision Consultant's Audits

The Construction Supervision Consultant may carry out audits of the Contractor's Quality Assurance Plan(s) and arrange inspections to ascertain that the Quality Assurance Plan is being complied with. If the Quality Assurance Plan is found by the Construction Supervision Consultant to be not functioning successfully, the Construction Supervision Consultant may

have the Quality Assurance Plan externally audited until it does function successfully. The external audits will be at the Contractor's expense.

Quality Certification

The Contractor shall carry out quality audits of his Quality Assurance Plan(s) on a regular basis. The Contractor shall submit written certification of the following to the Construction Supervision Consultant with every claim for payment:

- (1) That at least one quality audit has been performed within the previous 56 days and the date of the audit;
- (2) That the quality audit verifies that the work performed by the Contractor and all sub-contractors complies with the Contract requirements;
- (3) That the attached list of non-conformances is complete. The status of each non-conformance shall be reported; and
- (4) In the event that the Construction Supervision Consultant does not receive acceptable quality audit certification, the Construction Supervision Consultant may, at his sole discretion, adjust the amount payable under each claim for payment until acceptable quality audit certification is received.

Documentation

The Contractor shall maintain, in a readily accessible manner all documentation and records as are necessary to provide objective information or evidence in support of the Works meeting the various requirements of these Requirements and shall make them available for inspection by the Construction Supervision Consultant upon request. On completion of the Works the Contractor shall supply all, or such proportion as may otherwise be directed, of the documentation to the Construction Supervision Consultant.

The Contractor shall maintain all documentation dated and signed, demonstrating that the quality control procedures and activities specified, and within his Quality Assurance Plan are in compliance and are being carried out throughout the entire Contract Period.

The Contractor shall keep a system of records available for inspection by the Employer on the site. Records shall include, but not be limited to:

- Signed set of contract documents;
- An up-to-date set of Employer's and Contractor's drawings;
- Notices of amendments to drawings;
- Field instructions and notices from the Construction Supervision Consultant;
- Material and fabrication orders;
- Records of all material deliveries to site, and location of incorporation into the works;
- Certification records of all manufacturers of materials delivered to site;
- Equipment and instrumentation orders, including product data and documentation;
- Copies of all test certificates, with test type, location and result;



- Details of As-constructed work marked up on project drawings, updated weekly.

Equipment and Materials incorporated into the Works

All equipment and material products supplied to site, and fabrications off-site, for incorporation into the works shall be supplied from formally accredited companies with adequate quality systems in place to applicable international standards for quality assurance, as well as being accredited with the specified international technical standards for the production of such equipment, material or fabricated item, formally certified by authorised international third party certification authorities. Copies of certified quality and technical accreditation documentation shall be supplied to the Construction Supervision Consultant prior to any order being processed.

Non-Conformance

The Contractor shall immediately notify the Construction Supervision Consultant of every non-conformance of his Quality Assurance Plan, and as soon as possible thereafter, shall notify the Construction Supervision Consultant of his proposed corrective action.

The cost for adequate Quality Control, as required, shall be included overall in the amounts, rates, and prices in the Tender Price quoted by the Tenderer.

L2-5.1.3.9 Warranties

All Contractor supplied equipment for permanent installation into the works shall be new and unused, of most recent model, and shall be supplied with warranties valid for 12 months after acceptance into the works, against any defect arising from any act or omission by the Contractor or arising from design, materials, and workmanship, under normal use in the conditions prevailing in the country of final destination. The Contractor shall ensure that all warranty entitlements arising from the work include the Employer and Contractor as named beneficiaries. Such warranties shall be in a form approved by the Construction Supervision Consultant and shall be submitted to the Construction Supervision Consultant prior to the issue of the Final Payment Certificate.

L2-5.1.4 Control of Material

L2-5.1.4.1 Approval of Materials and Equipment

Only as-new materials and equipment shall be incorporated into the works. All materials and equipment furnished by the Contractor shall be in accordance with the specifications and subject to the inspection and approval of the Construction Supervision Consultant. No material shall be incorporated into the works without prior approval of the Construction Supervision Consultant. The Contractor shall submit to the Construction Supervision Consultant, all data relating to materials and equipment proposed to be furnished for the works, at least 21 days prior to purchasing or commencing such works. Such data shall be of sufficient detail to enable the Construction Supervision Consultant to identify the particular product and to form an opinion as to its conformity to the specifications.

All required facilities including labour for the handling and inspection of all materials and equipment shall be furnished by the Contractor at his own cost. Prior to commencement of the relevant works, the Contractor shall submit samples of materials and carry out special tests to demonstrate that they conform to the Employer's Requirements. Such samples shall be furnished, stored and tested as directed, at no extra cost to the Employer.

The Contractor shall submit data and samples sufficiently early but not less than twenty one (21) days prior to the approval-required date to permit consideration and approval before materials are ordered. Any delay of approval resulting from the Contractor's failure to submit samples or data timely shall not be used as a basis for any claim financial or otherwise against the Employer. In order to demonstrate the proficiency of workmen or to facilitate the choice among several textures, types, finishes and surfaces the Contractor shall provide such samples of workmanship of finish as may be required by the Construction Supervision Consultant.

No purchase order or manufacture for equipment or goods shall be made until the Construction Supervision Consultant has authorised such purchase/manufacture based on his approval of specifications, data sheets, shop drawings and all required and relevant documents submitted 21 days prior.

No shipment of equipment or goods shall be commenced until the Construction Supervision Consultant has authorised such shipment on the basis of:

- The Construction Supervision Consultant's previous approval of specifications, data sheets, shop drawings and other relevant documents;
- The Construction Supervision Consultant's approval of inspection reports by Himself, Employer and third parties, and following the requirements in accordance with the Particular Conditions of Contract;
- The successful inspection by the Construction Supervision Consultant/Employer, as applicable to the Contract.

The Contractor shall refer to the Bill of Quantities for the requirements for factory-witness tests or inspections in coordination with the above.

Pre-Shipment Inspection

The Contractor shall arrange Pre-shipment Inspection visit for Employer and Engineer (Construction Supervision Consultant) to country of manufacture before dispatching the below listed commodities. The duration for Inspection for each Inspection Visit shall not be less than 07 (Seven) days excluding travelling to Manufacturer's Country and back.

Each Pre-shipment Inspection should be done by two (02) Employer's Engineers before dispatching at Manufacturer's Country and inspections shall be made in respect of;

- (a) Pumps with a capacity over 100kW
- (b) The variable speed drives with a capacity over 100kW
- (c) Ductile Iron Pipes and fittings
- (d) Ductile Iron butterfly valves (Manual, Motor Operated)
- (e) Ductile Iron hydraulic valves
- (f) HDPE pipes and Fittings including Electro-fusion tapping saddles
- (g) Electromagnetic Flow meters
- (h) Power transformer
- (i) Generator
- (j) MV Panel components such as VCB
- (k) LV Panel components such as MCCBs
- (l) Instrumentation panels and SCADA

- (m) On street Pressure booster Pumps
- (n) Raw water transfer Submersible pumps of Kalurghat Iron Removal Plant (IRP)

The Contractor shall in his bid provide detailed proposals for pre-shipment inspection visit he offers to provide under this clause. The following guidelines shall be used by the Contractor to formulate his proposals.

- (a) The duration of inspection for each officer shall not be less than Ten days excluding Travelling time to the Manufacturer's country and back.
- (b) Most time shall be centered round the manufacturer's goods which the Contractor proposes to use in the work.
- (c) The inspection at the specific manufacturer shall include;
 - A general introduction to the manufacturer's country, area, town & source of materials.
 - Introduction to design standards and procedures adopted.
 - Introduction to relevant procedures and quality control standards.
 - Manufacturing process, and Quality Assurance procedure.
 - Testing procedures, mill certificates, product conformity certificate, Quality Management System Certificate and any other relevant certificates etc. regarding the products.
 - Packing & dispatching procedure
 - Site visits to inspect installed similar products.
- (d) The officers shall be guided by experienced engineers and quality controllers who are also competent in English language.
- (e) Air tickets, all visas, insurance, permits, taxes, travelling expenses, accommodation on full board basis, transfer fees, transport within the Manufacturer's country, transport to the airport and all other facilities and other minor expenses to perform the inspection during pre-shipment inspection visit at manufacturer's country shall be arranged and paid for by the Contractor.
- (f) The officers shall be provided with printed catalogues, manuals, illustrative videos etc., relevant to the manufacturing process and also obtain extra information requested by them, and shall arrange to dispatch these to Employer's Engineers, by the Contractor at his own cost.
- (g) Contractor shall provide a detailed program showing Inspection, travelling, and all other arrangement (i.e. Hotel locations etc.) for the pre-shipment Inspection and submit to the Inspection team prior to departure. The inspection Program shall be agreed with the Pre- Shipment Inspection team.
- (h) Nominated inspection agency should be present during pre-shipment inspection by the Employer and Engineer and should assist Employer and Engineer for the testing and inspection
- (i) Any inspections carried out by Inspection Agencies or Employer's shall not relieve the Contractor of his obligations under the Contract.

- (j) Contractor/Manufacturer shall not deliver/dispatch materials from the Factory or Stores without approval of the Engineer.

The cost of all foregoing expenses shall be given under the General Item provided for this purpose.

L2-5.1.4.2 Equivalent Materials and Equipment

Whenever a material is specified by using the name of the standard and / or class internationally accepted, the specified item mentioned shall be understood as the minimum acceptable standard. Other material may be accepted provided that sufficient information is submitted as specified elsewhere in these Requirements to allow the Construction Supervision Consultant to determine that the materials proposed are equivalent or better than those named. Such items shall be submitted before 21 days prior to the expected date of approval by the Construction Supervision Consultant for review by the procedure set forth in Clause L2-5.1.3 of this Specification "Submittals".

L2-5.1.4.3 Handling and Storage of Materials

The Contractor shall make every effort to minimise extended storage periods for material, plant and equipment at the Site by scheduling the deliveries to coincide with the construction needs. The Contractor shall not store unnecessary materials, plant or equipment at the Site and shall take care to prevent any structure from being loaded with such weight, which will endanger the structure or the safety of persons. The Contractor shall observe and follow regulatory signs for loading of any structures and other safety precautions. The Contractor shall obtain from the manufacturers sufficient information detailing the method of storage and the maintenance of the stored items and shall comply with these requirements to the satisfaction of the Construction Supervision Consultant. Any costs associated with the storage and protection of materials and equipment shall be deemed to be borne by the Contractor and will not be separately paid for. No material, plant or equipment shall be brought to the Site until the following conditions are met:

- (1) The manufacturer's instructions for the Site storage have been submitted to the Construction Supervision Consultant; and
- (2) The storage area has been identified by the Contractor and approved by the Construction Supervision Consultant.

The Contractor shall take all necessary precautions to protect Plant delivered to site. The Contractor shall every month give to the Construction Supervision Consultant a statement showing the amount of Plant and Contractor's Equipment, which has been brought to Site or which is in transit.

The Contractor shall arrange to have clear markings on each package as required by the Construction Supervision Consultant with weight, width, length and height of each package on the sides. The Contractor shall make sure and be solely responsible that the Plant is packed securely and safely enough to prevent deterioration, knocks, or causing any damage during transportation, transit, storing and handling from when the Plant is dispatched up to Taking Over.

Cement and lime shall be stored off the ground, covered and kept completely dry at all times. All structural steel, miscellaneous steel and reinforcing steel shall be stored off the ground or otherwise to prevent accumulations of dirt or grease and in a position to prevent accumulations of standing water to minimise rusting. Beams shall be stored with the webs

vertical. Pre-cast concrete elements shall be handled and stored in a manner to prevent accumulations of dirt and stagnation of water, staining, chipping or cracking. Masonry products shall be handled and stored in a manner to reduce breakage, chipping, cracking, and spilling to a minimum.

Any materials considered to be damaged or unfit for their intended use or not as specified for the work, in the opinion of the Construction Supervision Consultant, shall be promptly removed from the site of the work and the Contractor shall not be liable for any compensation for the replacement of the damaged material or its removal. After placement of the backfill, all surplus material shall be removed immediately from the site by the Contractor.

Construction materials shall not be stored in streets for more than five (5) days after unloading. All materials and equipment not installed or used within the construction within five (5) days after unloading shall be stored elsewhere by the Contractor at his expense unless additional storage time has been prior approved by the Construction Supervision Consultant.

L2-5.1.4.4 Materials Stock Control

The Contractor shall store all goods in a methodical and systematic manner, particularly the materials to be used in the Permanent Works, in order to control his work efficiently and also to permit the Construction Supervision Consultant to physically monitor the quantities in stock. The Contractor shall submit his up-to-date stock list of materials required for the Permanent Works at each month or at such other times as may be requested by the Construction Supervision Consultant. In any case, such material list shall form part of the submission with his monthly valuation certificate.

L2-5.1.4.5 Salvage of Materials and Equipment

Any existing materials or equipment that were removed and not reused as a part of the works shall remain the property of the relevant agency. The Contractor shall carefully remove in a manner to prevent damage to materials and equipment specified or indicated to be salvaged and reused or to remain the property of the relevant agency. He shall store and protect salvaged items specified or indicated to be reused in the work. Salvaged items not to be reused in the works but remain the property of the relevant agency shall be transported and delivered by the Contractor in good condition to the owner as may be decided by the Construction Supervision Consultant.

Items damaged during removal, storage, handling or transportation through carelessness or improper procedures shall be replaced by the Contractor in kind with new items at his own cost. The Contractor may at his own discretion and expense furnish and install new items acceptable to the Construction Supervision Consultant without additional cost in lieu of those specified or indicated to be salvaged and reused. In such event, the removed items shall become the property of the Contractor. Existing materials and equipment removed by the Contractor shall not be reused in the works except where so specified or indicated.

L2-5.1.5 Temporary Facilities

L2-5.1.5.1 Field Office for the Contractor

Field offices for the Contractor shall be established in proximity to each job site at the location approved by the Construction Supervision Consultant and shall be maintained in a clean orderly condition by the Contractor for the duration of construction, unless earlier removal is authorised by the Construction Supervision Consultant. Boundaries of the Contractors offices, work-yards, workshops, depots and stores shall be agreed with the Construction Supervision Consultant. Proper fencing, including lockable gate, shall be

provided by the Contractor along the agreed boundaries. One office shall be suitable for site meetings with the Construction Supervision Consultant and be furnished, have electricity supply, lighting, ceiling fans, air conditioner and telephone, car parking, and complete within a period of thirty (30) calendar days after signing of the Contract Agreement, and maintained by the Contractor until the issuance of Taking-Over Certificate for the Works. The Contractor or his authorised representative shall be present in the office at all times while work is in progress. Instructions received there from the Construction Supervision Consultant shall be considered as delivered to the Contractor. The Contractor shall also provide mobile offices for each construction work site as required.

All costs for the Contractor's Field Office shall be deemed covered within his prices under the relevant item in the Bill of Quantities.

L2-5.1.5.2 Laboratory Tests

The Contractor shall provide information on his designated Laboratory for field tests which shall be a well maintained facility operational during the entire construction period, located in the Project area, and shall be approved by the Construction Supervision Consultant. The Field Laboratory shall be adequately furnished and equipped with sufficient equipment and apparatus for the purpose of carrying out the required soil and concrete tests under the contract. The laboratory equipment and apparatus shall be of approved types and shall be adequate in the opinion of the Construction Supervision Consultant to carry out all the tests as listed in the Employer's Requirements. The Contractor shall carry out all testing in the presence of the Construction Supervision Consultant's representative throughout the duration of the Contract.

The Contractor shall use competent or authorised (if required) laboratory technicians for the tests. All costs for laboratory testing shall be deemed covered by the Contractor within his relevant prices in the Bill of Quantities.

L2-5.1.5.3 Water

The Contractor shall be responsible for the provision and maintenance of adequate supply of potable water for the use of the Contractor and his subcontractor's workmen for construction and human consumption. He shall install and maintain necessary supply connections and piping for the same but only at such locations and in a manner as may be approved by the CWASA and Construction Supervision Consultant. These temporary connections and piping installed by the Contractor shall be removed to the satisfaction of the CWASA and Construction Supervision Consultant before final acceptance of the Works.

L2-5.1.5.4 Electricity

All electrical power required by the Contractor to service the sites for the works shall be provided by the Contractor at own cost. All temporary connections for the power supply shall be subject to the approval of the Construction Supervision Consultant. Temporary lines shall be arranged, furnished, installed, connected, all costs paid for and maintained by the Contractor in a workmanlike manner throughout the Contract in accordance with the acceptable safety standards and to the satisfaction of the Construction Supervision Consultant. These facilities shall be removed by the Contractor in like manner prior to final acceptance of the works unless requested by the Construction Supervision Consultant otherwise.

L2-5.1.5.5 Sanitary Arrangements

The Contractor shall provide and maintain temporary sanitary facilities such as pour flush latrines and septic tanks on the sites for the use of all persons connected with the work. The Contractor shall keep the site in a clean and sanitary condition and shall post notices and take such precautions as may be necessary to keep the site clean. The Contractor shall carry out any cleaning whatsoever as may be directed by the Construction Supervision Consultant to maintain such sanitary conditions acceptable.

L2-5.1.5.6 First Aid

The Contractor shall provide all necessary first aid facilities, attendants and supplies for his labour force, all sub-contractors and suppliers in accordance with all government rules and regulations and all other statutory requirements and / or to the satisfaction of the appropriate government departments, the Employer and the Construction Supervision Consultant.

L2-5.1.5.7 Barricades and Lights

All streets, roads, highways and other public thoroughfares, which are allowed by the authorities to be closed to traffic, shall be protected by effective barricades on which lights and acceptable warning signs shall be placed. Barricades shall be located at the nearest intersecting public highway or street on either side of the blocked section.

All open trenches and other excavations shall have suitable barricades, warning signs, and lights to provide adequate protection to the public. Obstructions such as material piles and equipment shall be provided with similar warning signs and lights. All barricades and obstructions shall be illuminated with warning lights from sunset to sunrise. Material storage and conduct of the work on or alongside public streets and highways shall cause minimum obstruction and inconvenience to the travelling public.

All barricades, traffic cones, warning tapes, signs, lights and other protective devices shall be installed and maintained in conformity with applicable statutory requirements and, where within railroad and highway right-of-way, as required by the agency having jurisdiction thereupon.

L2-5.1.5.8 Fences

All existing fences affected by the works shall be maintained by the Contractor until completion of the works at no extra cost to the Employer. Fences which interfere with construction operations shall not be relocated or dismantled until written permission is obtained from the owner of the fence and the period the fence may be left relocated or dismantled has been agreed upon. Where fences must be maintained across the construction easement, adequate gates shall be installed. Gates shall be kept closed and locked at all times when not in use.

On completion of the work across any tract of land, the Contractor shall restore all fences to their original or to a better condition and at their original location without any additional cost to the Employer. It is the Contractor's responsibility to locate the fence correctly.

L2-5.1.5.9 Protection of Public and Private Property

The Contractor shall protect, shore, brace, support, and maintain all structures, underground pipes, conduits, drains and other underground constructions uncovered or otherwise affected by his construction operations. All pavement, surfacing, driveways, curbs, walks, buildings, utility poles, guy wires, fences and other surface structures affected by construction operations together with all trees and shrubs in yards and parking shall be restored to their

original condition, whether within or outside the easement. All replacements shall be made with new materials.

The Contractor shall be responsible for all damage to structures, streets, roads, highways, shoulders, ditches, embankments, culverts, bridges, and any other public or private property, regardless of location or character, which may be caused by transporting equipment, materials, or people to or from the works, or any part or site thereof, whether by him or his sub-contractors. The Contractor shall make satisfactory and acceptable arrangements with the owner of, or the agency or authority having jurisdiction thereupon, the damaged property concerning its repair or replacement or payment of costs incurred in connection with the damage.

In the event of any claims for damage or alleged damage to property as a result of work under this Contract, the Contractor shall be responsible for all costs in connection with the settlement of or defence against such claims. Before the final certificate will be issued, the Contractor shall furnish satisfactory evidence to the Construction Supervision Consultant that all claims for damage have been amicably and legally settled.

All fire hydrants and water control valves shall be kept free from obstruction and available for use at all times. The Contractor shall minimise the cutting and removal of trees and other vegetation. All cutting and removal shall be with the approval of the Construction Supervision Consultant, and if necessary, with the approval of the relevant Government Authority.

L2-5.1.5.10 Security

The Contractor shall be responsible for protection of the sites and all works, materials, equipment and existing facilities thereof against vandals and other unauthorised persons. No claim shall be made against the Employer by reason of any act of an employee or trespasser and the Contractor shall make good all damage to the property of the owner resulting from his failure to provide security measures as specified. Security measures shall be at least equal to those usually provided by the CWASA to protect the similar existing facilities during normal operation but shall also include any additional security fencing, barricades, lighting, watchman services or other measures as required to protect the site. Costs for all security measures shall be deemed covered generally by the Contractor within his rates and prices.

L2-5.1.5.11 Access Roads

The Contractor shall arrange with property owners to establish and maintain temporary access roads to various parts of his sites as required to complete the Works at his own cost. Such roads shall be available for the use of all others performing work or furnishing services in connection with the Contract. Existing public access roads used by the Contractor in connection with the execution of the Contract shall also be maintained by the Contractor.

L2-5.1.5.12 Parking

The Contractor shall provide and maintain suitable and adequate parking areas for the use of all construction workers and others performing work or furnishing services in connection with the Contract at the sites as required to avoid parking personal vehicles where they may interfere with public traffic, property owner's operations or construction activities.

L2-5.1.5.13 Temporary Drainage Provisions

The Contractor shall provide for the drainage of storm water and such water as may be applied or discharged on the site in performance of the work at own cost. Drainage facilities shall be adequate to prevent damage to the work, the site, and adjacent property.

Existing drainage channels and conduits shall be cleaned, enlarged or supplemented as necessary to carry all increased runoff attributable to the Contractor's operations. Dikes shall be constructed as necessary to divert increased runoff from entering adjacent property (except in natural channels) to protect property owner's facilities and the works and to direct water to drainage channels or conduits. Stilling Pools shall be provided as necessary to prevent downstream flooding.

L2-5.1.5.14 Fire and Explosion Protection

The Contractor shall take all necessary precautions to prevent fires at or adjacent to the work, buildings, etc., and shall provide adequate facilities for extinguishing fires which may occur. No burning of trash or debris will be permitted anywhere on the site.

When fire or explosion hazards are created in the vicinity of the work as a result of the locations of fuel tanks, or similar hazardous utilities or devices, the Contractor shall immediately notify the Construction Supervision Consultant of such risks. The Contractor shall exercise all safety precautions and shall comply with all regulations and instructions issued by the local authorities and the Construction Supervision Consultant to prevent the occurrence of fire or explosion.

Particular care must be exercised regarding the operation of welding and cutting equipment and other processes involving the use of naked flame.

L2-5.1.5.15 Cleaning

General

The Contractor shall remove from the sites and dispose of all debris and rubbish resulting from his operations at least once a day and more often if the same interferes with the work under the Contract or the work of other service, or present a fire or accident hazard.

All debris, waste, rubbish and scrap pieces resulting from clean-up operations shall become the property of the Contractor and shall be removed from the site in an acceptable manner, not creating nuisance on the streets or adjoining property owners and shall be disposed of according to the prevailing legal requirements and in accordance with the requirements of Section L2-1,4.

The Contractor shall thoroughly clean and remove all mortar droppings, marks of concrete leakage, formwork marks, tar spatters and paint droppings.

Final Cleaning

After completing and testing (if required) of the works, the Contractor shall remove all rubbish and excess earth from and in the vicinity of the work, and all temporary structures, construction signs, tools, scaffolding, materials, supplies and construction machinery or equipment which he or any of his subcontractors may have used in the performance of the works. The Contractor shall clean all the works and leave the sites and the surroundings in neat condition.

Final cleaning of network construction areas shall be completed within seven (7) days of reinstatement of the surface.

Employer's Right to Clean

Should the Contractor fail, refuse or neglect to remove rubbish and waste materials and temporary work or clean his working areas as required herein, then the Employer may, without any obligation to do so, remove and dispose of the said rubbish, waste materials and temporary work, clean the Contractor's working areas and deduct the cost thereof from any money due, or to become due to the Contractor under this Contract.

L2-5.1.5.16 Site Clearance

Clearing

The Contractor shall clear the reservation widths for the sites for structures and pipelines free of all vegetation, and all superficial obstacles such as road surfaces, concrete surfaces, bricks, and rubbish. Removal of trees shall be dependent on the approval of the Construction Supervision Consultant.

The extent of Contractor's clearing and grubbing, and disposal, operations shall be the minimum practicable necessary in the opinion of the Construction Supervision Consultant for the construction of the Works and shall be included under the respective item in the Tender.

All vegetation, trees, etc. arising from the clearing and grubbing operations shall be disposed at a depot within a radius of approximately 20 kilometres to a location directed by the Construction Supervision Consultant. Remnants of vegetation, including trees, stumps and roots, shall be disposed off-site by the Contractor unless otherwise directed by the Construction Supervision Consultant.

Road Furniture

The Contractor shall re-install any road furniture (such as street lighting, traffic signs or traffic lights) that had to be removed during the progress of the Works. The installation of the road furniture shall take place at its original location, in a condition at least equal to that prior to removal and as soon as practicable after completion of pipe laying in that area. Costs shall be included generally within the rates and prices in the Tender.

Protection from the Works

The Contractor shall not demolish or remove any existing buildings, structures or other objects including trees, whether indicated on the Drawings or not, unless on a specific written instruction from the Construction Supervision Consultant. The Contractor shall take every care and precaution to protect from damage any of these objects, including houses, buildings, fences or trees, which are situated on or near the site. Every care shall be taken not to damage walls, and if pipework is crossing a wall, the Contractor shall burrow underneath it.

Any property situated in close proximity to the works shall be protected against damage which may be caused by vehicles, subsidence, vibration, etc. Any damage caused shall be repaired by the Contractor to conform to the condition of the property prior to damage and the Construction Supervision Consultant's satisfaction.

Any fences cut, removed or moved during the execution of the work shall be replaced and reinstated to its original alignment unless otherwise directed by the Construction Supervision Consultant. It is the Contractor's responsibility to ensure that the fence is located correctly.

Costs shall be included generally within the rates and prices in the tender to protect and repair damage to any objects in the vicinity of the Works.

L2.5.1.5A Facilities for the Employer's Staff

The Contractor shall provide a fully furnished and maintained Site Office with a minimum area of 100 square meters for the entire duration of the Contract. The office must include all necessary facilities such as furniture, air conditioning, lighting, water, communication and electrical services. It should also be equipped to support construction management services and provide a designated meeting room for meetings with the relevant Stakeholders. The Site Office must have sanitary and first aid facilities and all its facilities must be maintained in good working condition throughout the Contract period, with regular cleaning, repairs, and replenishment of necessary supplies.

In addition to the above, the Contractor shall procure two brand new Double-Cab Vehicles and one Car for the use of the Engineer/Employer, which shall be fully maintained throughout the Design and Construction Period. These Vehicles shall remain in service and be properly maintained by the Contractor with comprehensive insurance coverage until the completion of the Works. At the end of the Design and Construction Period, these Vehicles will become the property of CWASA. The briefed Technical Specifications for the Vehicles are as follows:

- **Car:** One (01) Petrol-driven, 2,400 CC, Sedan Car, fully equipped with all available options, including but not limited to Air Conditioning, Power Windows, Leather Seats, Navigation System, advanced safety features (*such as airbags, anti-lock braking system, and traction control*), and Automatic Transmission.
- **Double Cab Vehicles:** Two (2) 2,800 CC, Diesel-driven, 4WD Double-cab Pickup, with Factory-Fitted Canopies, Automatic Transmission, and fully equipped with all available options, including but not limited to Air Conditioning, Power Steering, Power Windows, advanced safety features, and additional features suitable for off-road and heavy-duty use.

The Contractor is required to propose Vehicles that meet or exceed the above Specifications and submit detailed Vehicle Proposals for CWASA's approval before Placing the Order. No Orders shall be Placed, without prior approval from the CWASA.

All costs for the Site Office facilities for Employer's Staff and the Procurement, Maintenance, and Operation of 03 Vehicles shall be deemed covered within the Contractor's Prices under the relevant item in the Schedules of Activities.

L2-5.1.6 Special Provisions

L2-5.1.6.1 General

The Conditions of Contract, Drawings and the Bills of Quantities, Rates and Unit Prices are to be read in conjunction with the Employer's Requirements. Matters referred to, shown or described in any of the former are not considered to be repeated in the latter.

Notwithstanding, the subdivision of the Employer's Requirements under different headings, every part of it shall be deemed supplementary to and complementary to every other part.

The Contractor is required to carry out instructions set out below at no additional cost to the Employer. All costs relating to the following special provisions shall be deemed to be included generally, or within the relevant items provided in the Bill of Quantities.

L2-5.1.6.2 Work in Roads**(a). General**

Procedures for dealing with Road Authorities (RA) for entering into and for cutting roads for the purposes of pipe laying, junction connections, installation of chambers valves etc., and making connections to existing pipelines, backfilling and temporary reinstatement etc. are set out below:

1. The Contractor shall produce his proposed overall programme and sub-programmes for each road section for installation works in roads for discussion with the Construction Supervision Consultant and Employer at the specified time after award of Contract to show the date of start and completion of excavation, laying, temporary reinstatement, hydraulic pressure testing, backfilling, compaction and temporary reinstatement in each road for the following:
 - (i) Pipelines along roads.
 - (ii) Junction connections,
 - (iii) installation of valves & chambers, tapping of existing lines.
 - (iv) Pipelines across roads (Road Crossings).
 - (v) Leak repairs within an identified stretches

Note :

- For leak repairs in certain designated areas (e.g., within the 3 identified DMAs), road cutting permissions shall be requested with specific limitations on the excavation area, as mutually agreed with the Road Authority
 - Programmes for this work shall allow for the time needed for prior Road authority approvals, trial pits, and any ordering, manufacture, transport, and delivery of pipes and any special imported fittings.
2. When satisfied with the construction programme, the Employer shall present it to RA who may propose changes to the sequence according to their own road improvement programme, if any. The Contractor shall allow for a reasonable amount of disruption to his programme, and he shall not be entitled to specific extra cost or extension of time that reasonably may arise as a result of RA's comments.
 3. The Contractor shall produce a final programme for action incorporating any changes requested by the Employer, following discussions with the RA.
 4. The Employer shall agree with the RA the estimated permanent reinstatement costs for the roads programmed for entry, and RA shall execute works within the time period according to the Contractor's approved programme or such other period as may be found more practical, or appropriate.
 5. The Employer (CWASA) shall pay the RA the agreed estimated amount. The Contractor shall apply for permission to excavate the defined roads prior payment to the RA by the Employer with permission granted thereafter.

6. Road Crossings: Road Authority requirements are that Road Crossings may only be carried out at times of low traffic density such as at night, at weekends and during public holidays, and the Contractor must prepare his programme accordingly. Contractor must allow in his rates for his extra costs involved in such work outside normal working hours.
7. Compaction of the backfilling in trenches in roads shall exceed 95% of the maximum dry density or percentage as specified in the Clause for "Backfilling Trench Excavations – Compaction" on the Modified Proctor Test (of that relevant Part of the Employer's Requirements). The Contractor shall allow all costs for testing facilities and for ensuring correct moisture content to achieve the required minimum compaction. Compaction tests of trench backfill shall be carried out where-ever directed and results shall be to the satisfaction of the Construction Supervision Consultant.
8. The Contractor shall use Asphalt Cutters and Pneumatic Tyre Wheeled Excavators for roadworks to minimise damages to the adjacent road-wearing surface. The Contractor shall make all the arrangements for any temporary work, scaffoldings etc. at his own cost, with the permission of the relevant authorities where required.
9. The Contractor is required to liaise closely with the Road Authorities, whose responsible officers are: Road Authority Regional Offices in the Project Areas.

(b) Road Crossings

The Contractor shall submit through the Construction Supervision Consultant to the relevant Road Authority, a Method Statement and obtain Construction Supervision Consultant's and relevant Road Authority's prior approval before commencement of work on any road crossing. The Method Statement shall include traffic by-pass arrangements (where required) and the safety measures proposed during day and night. The Contractor shall maintain sufficient unobstructed width of the carriageway at any given time and this width shall not be less than is adequate to permit single lane traffic.

The Contractor shall adequately protect all existing service mains throughout the construction and he shall ensure that all existing services operate without interruption. The Contractor shall provide adequate temporary supports to all existing service mains, which are either exposed or partially exposed or otherwise weakened by the trench excavation, as specified above.

L2-5.1.6.3 Works within Areas of Private and Public Property

The Contractor shall take special care to avoid unnecessary damage to private and public property and he shall pay the compensation for such damage as may in the opinion of the Construction Supervision Consultant be due to the execution of the work in a careless or un-workmanlike manner. Should the Contractor require, for any purpose, additional land beyond the site areas as depicted on the Drawings, he shall provide it at his own cost and shall forward to the Construction Supervision Consultant a copy of the permits from the owner and occupier of such additional land before entering thereon. No additional payment shall be allowed for such costs in the rates and prices of the Bill of Quantities.

Where works involving pipelines are carried out through, between or under buildings or other structures, the gardens, orchards or curtilage of private houses and business premises or in

other cases which in the opinion of the Construction Supervision Consultant render it impracticable or unreasonable for a specified width to be obtained for the construction of the works, Contractor shall be deemed to have made allowance in his Tender during visits to the site for any extra expense which may be incurred in carrying out the work in the restricted width available.

The Contractor shall not disturb any monuments, property corners or survey markers without permission from the Construction Supervision Consultant and he shall bear the expense of resetting any monuments, property corners or survey markers, which may be disturbed. The Contractor shall be responsible for all damages to streets, utilities, railways, roads, highways, ditches, embankments, canals, bridges, culverts or other public or private property which may be caused by transporting equipment, materials, or men to or from the work. The Contractor shall make satisfactory and acceptable arrangements with the property owner over the damaged property concerning its repair or replacement.

L2-5.1.6.4 Railway Crossings

The Contractor is expected to construct the duct and carry out all associated construction work within the way leave under the supervision of Bangladesh Railway Authority. Contractor shall supply all the materials, equipment and labour as required by the Bangladesh Railway Authority and carry out the construction of the duct. On completion of the construction of duct by the Contractor to the satisfaction of Bangladesh Railway Authority, the Contractor shall proceed with the laying of the required main through the duct, including sealing the duct on completion, to satisfaction of the Construction Supervision Consultant and Bangladesh Railway Authority.

The Contractor shall allow in his rates for making himself aware of, and fully complying with the regulations and requirements of the Bangladesh Railway Authority whilst working in the vicinity of the railways. The Bangladesh Railway Authority is responsible for the removal of rails and sleepers and subsequent reinstatement of the tracks after the construction of the duct for which a payment is made to Bangladesh Railway Authority under provisional sum. The Contractor is required to liaise closely with the Bangladesh Railway Authority whose responsible officer is:

NEED TO UPDATE ADDRESS

The Contractor may be instructed to use thrust-boring technique instead of the open trenching method described above. The Contractor's rate for railway crossings shall include the cost to be incurred in any of the two techniques without additional cost to the Employer.

L2-5.1.6.5 Connections of New Mains to Existing Service Mains

The Contractor shall carry out connections to existing mains as explained in the scope of work.

Connections to existing mains shall be carried out, under the supervision and presence of and be co-ordinated closely with the CWASA and Construction Supervision Consultant in order to avoid water supply disturbances to the highest extent possible. No existing valve shall be operated by persons other than authorised CWASA staff. Prior to any connections, the Contractor shall liaise with the Operations and Maintenance Division of CWASA at least 2 weeks in advance. The Contractor shall prepare a method statement for major connections and shall obtain CWASA and Construction Supervision Consultants' prior approval. The Contractor shall carefully plan and organise all works and fittings, and any associated



construction works before interruption to the existing water supply to ensure a rapid cut-in and connection for the works. The Contractor shall ensure that all the necessary pipes, fittings, & equipment required for the works and bypasses, including those for an emergency situation, are available before commencement of the works. The Contractor is required to properly organise the works and carry out construction works in the most efficient manner and ensure that the period of interruption to the water supply is reduced to the minimum.

L2-5.2 Design Requirements

The sub-section explains the Employer's special requirement and guidelines which are to be followed by the Contractor while undertaking the detailed design of the works and covers the following topics:

- Hydraulic Design of Pipe Network
- Pipe Laying Detailed Design
- Pump House Design
- Design Requirement on Civil & Structural Works.

L2-5.2.1 Hydraulic design of Pipe Network

- Contractor shall submit the detailed program of Works with critical path analysis within the time stated in the Particular Conditions of Contract
- Contractor shall consider the model given by the client as a base model and conduct such investigations and surveys as may be necessary to discover and incorporate any additions and changes to the physical network found to be absent or incorrect.
- Contractor shall use WATER GEMS or equivalent software for his design work and shall run the model in EPS (extended period simulation) mode.
- Main design Criteria for hydraulic modelling work,
 - Daily Maximum flow: The Daily maximum flow factor for the Sectors is 1.15,
 - Hourly Demand Pattern for EPS Run: Two different fluctuations shall be considered.

i. DD Demand Pattern (Domestic Demand)

Time from Start (hr)	Multiplier	Time from Start (hr)	Multiplier
1.00	0.40	13.00	1.25
2.00	0.35	14.00	1.20
3.00	0.34	15.00	1.16
4.00	0.35	16.00	1.12
5.00	0.55	17.00	1.14
6.00	1.16	18.00	1.24
7.00	1.50	19.00	1.38
8.00	1.45	20.00	1.31
9.00	1.40	21.00	1.03
10.00	1.38	22.00	0.77
11.00	1.37	23.00	0.55
12.00	1.30	24.00	0.40

ii. NDD Demand Pattern (Non-Domestic Demand)

Time from Start (hr)	Multiplier	Time from Start (hr)	Multiplier
1.00	0.67	13.00	1.30
2.00	0.67	14.00	1.30
3.00	0.67	15.00	1.30
4.00	0.67	16.00	1.30

Time from Start (hr)	Multiplier	Time from Start (hr)	Multiplier
5.00	0.67	17.00	1.30
6.00	1.67	18.00	1.16
7.00	0.98	19.00	1.02
8.00	1.30	20.00	1.87
9.00	1.30	21.00	0.67
10.00	1.30	22.00	0.67
11.00	1.30	23.00	0.67
12.00	1.30	24.00	0.67

- An allowance of 20% as NRW for downstream of each distribution centre shall be **considered for the design and simulated as a pressure dependent flow.**
- Node elevations shall be taken from the survey which shall be carried by the contractor.
- Roughness Coefficients (e Value): - Darcy-Weisbach e value for new HDPE pipes 0.03 and new DI pipes 0.3048
- Pressure and Velocities: - Maximum velocity : 2.5 m / s
Minimum Residual pressure : 1 bar
Maximum Head loss gradient : 5m / km
- Pipe Material : Up to 630 mm (OD) - HDPE (BS EN 12201-2:2011
600 mm (ND) and above - Ductile Iron (BS EN 545)
- The Contractor shall update demand allocations to nodal points based on the most recent billing records of connected customers and their water usage, the detailed results of the 2022 population and property census for the Enumeration Areas in the Lot 2 Supply Area and submit a comparison of the base and updated demand allocations to nodal points to the Construction Supervision Consultant for approval.
- The Contractor shall record simultaneous measurements of flow and hydraulic head at all supply points, pumping stations and reservoirs and of hydraulic head only at or close to at least 10 percent of the junctions between pipes with internal diameters exceeding 130mm, evenly spread across the network, at time intervals of no greater than 5 minutes for a continuous period of at least 24 hours at all measurement locations to obtain reference data on actual flows and hydraulic heads in the existing distribution system.
- The Contractor shall use the hydraulic model to simulate the behaviour of the real network over the duration of the 24-hour simultaneous measurements of flows and hydraulic heads and use any discrepancies between the simulated and recorded pressures and flows to identify and correct errors and omissions in the updated hydraulic model as a result of:
 - Firstly, data entry errors (e.g. units, typographic, dimensions);
 - Secondly, incorrect representation of operational details, such as valve settings, pump characteristics and controls, etc.;
 - Thirdly, incorrect representation of pipeline connectivity, missing pipes, incorrect diameters, etc.;
 - Lastly, incorrect representation of customer usage.
- As soon as the differences between the simulated and measured flows and hydraulic heads are within the following tolerances then the Contractor shall submit a detailed

Hydraulic Model Calibration Report to the Construction Supervision Consultant for approval:

- Flow 100% of model flows within 5% of recorded flow
80% of model flows within 2.5% of recorded flow
 - Hydraulic Head 100% of model heads within 2.0m of recorded head
80% of model heads within 1.0m of recorded head
 - Reservoir water level 100% of model levels within 200mm of recorded level
80% of model levels within 100mm of recorded level.
- The Contractor shall use the calibrated hydraulic model approved by the Construction Supervision Consultant to review the hydraulic performance of the network improvements and DMA boundaries provided with these Tender Documents and propose any changes to their design that demonstrate improved levels of service to customers and operational cost savings to CWASA, such as energy saving by reducing head at the supply pumps, in a Network Design Report to be submitted to the Construction Supervision Consultant for approval no later than 9 months after Contract Signature.
- Before commencing the detailed design of an approved pipeline the Contractor shall:
 - carry out detailed topographical surveys (Longitudinal and Plan) of all the proposed pipe routes together with any contour and geotechnical surveys that may be necessary at proposed meter chamber, in-line booster, line valve and other necessary locations.
 - submit all survey and geotechnical drawings the Construction Supervision Consultant for review
 - perform such additional surveys and checks as the Construction Supervision Consultant shall require.
- the Contractor shall update the approved calibrated hydraulic model according to the above surveys and submit the revised model to Construction Supervision Consultant for approval.
- Primary feed main pipe alignments and diameters shall not be changed by the Contractor during the detailed design stage, unless instructed by the Construction Supervision Consultant.
- Contractor shall use the approved calibrated hydraulic model and site surveys to modify the infilling pipe routes, diameters and connectivity as necessary to optimize the design.
- The Contractor shall only amend approved DMA boundaries when required to do so by the Construction Supervision Consultant.
- Feeding point of each DMA to be confirm with Construction Supervision Consultant. If any changes identified relevant change of pipe length or diameter of the Primary main shall be adjusted by the Contractor.
- The Contractor shall submit shop drawings for any special river crossings, highway, railway and bridge crossings or special details such as shoring, temporary works, junction details to Construction Supervision Consultant for approval.

L2-5.2.2 Pipe Laying Detailed Design

The Contractor shall:



- follow the following design criteria for pipe design works:

Minimum Cover	1.0 m for all pipes except nearby DMA meter chambers with DI pipes where it is permitted to keep minimum 0.6m. Refer standard drawing CWSIP/P1L1/STD/001
Air Valves	Critical high points, bridge crossings, Type E crossings, pipes on supports, along the pipeline. Spacing approximately 500m to 750m Pipe Diameter and size of Air valves: Refer standard drawings, nearby DMA meter chambers where the level of pipe is raised to keep minimum cover as 0.6m.
Washouts	Lowest locations of the pipeline, possible places of end of pipelines. Pipe Diameter and size of Washout: Refer standard drawings
Flow meters	Inlets of each Sector and DMA, major branches if required
Control Valves (Section Valves)	Approximately about 1.5 to 2 km intervals

- avoid routing pipelines through highly productive agricultural land, forests or other areas where environmental damage is high
- ensure correct procedures for right of access, and follow essential acquisition procedures for pipelines crossing private land, and access will also be required for surveys and subsequent maintenance
- obtain necessary local authority planning permissions, and approvals from any other concerned authority, i.e. road, railway, irrigation, etc.
- anchor pipelines against thrusts resulting from test pressures, normally 15bar, and of system operating pressure, consider at all changes in direction (thrust block design shall be submitted to the Construction Supervision Consultant for approval)
- provide rider mains along each side of major highways to avoid the necessity to lay service connections across them
- investigate potential conflicts with other utilities (sewer, telecom, electricity, gas, etc.) and design the pipeline route or location to suit the relevant local or international codes.

L2-5.3 Pump House Design

L2-5.3.1 General

Pump house to be designed based on the given drawings. Contractor shall consider that the main key elements of the pump station comprise but are not limited to: dry well, pumps, piping with associated valves and strainers, motors, power supply system, equipment control and alarm system, odour control system, ventilation system, operator accommodation. The Contractor shall further consider the following during design and detailing:

- Invert of the suction pipe shall match with the bottom water level.
- The size of the pump house is to be designed to accommodate the pumps, control panels, valves, and other necessary equipment, as well as provide sufficient space for maintenance and repairs.

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- Adequate security measures shall be provided to protect the pump house and its equipment from unauthorized access, vandalism, or theft. This shall include but not be limited to locks, alarms, and security cameras.
- The pump house shall have proper access points, such as doors or hatches, for personnel to enter and exit. These entryways shall be large enough to accommodate equipment removal or replacement, if necessary.

L2-5.3.3 Structural Design

Contractor shall follow the standards indicating in the Structural specification section.

L2-5.3.4 Building Services Design

Contractor shall follow the international or locally acceptable standards to the Construction Supervision Consultant for the following building services not limited to:

- Ventilation and Air-conditioning
- Plumbing System
- Water Supply
- Drainage
- Plumbing Fixtures
- Fire Protection System
- Lighting and socket outlet system



L2-5.4 Design Requirement on Civil & Structural Works

The sub-section explains the Employer's general requirement and guidelines for Civil and Structural works, which are to be followed by the Contractor while undertaking the detailed design of the works and covers the following topics,

- General
- Concrete
- Reinforcement
- Structural Design Standards
- Pre-stressed Concrete
- Structural Analysis and Design Procedures
- Design of Water Retaining and Ancillary Structures
- Design Loads
- Foundations

L2-5.4.1 General

The structural analysis and design shall be based on one of the computer packages "Prokon", SAP 2000 or STAAD.Pro

L2-5.4.2 Concrete

Concrete for all water retaining structures and pump stations comprising reinforced non-pre-stressed, cast in place construction shall be grade 35A, having a characteristic strength of 35N/mm^2 . Concrete for pre-stressed elements, if required, shall be factory-controlled grade 40 concrete (40 N/mm^2). Blinding concrete under footings and slabs of water retaining structures shall be grade 20 (20 N/mm^2). Prior to laying structural concrete a polythene film of thickness not less than 0.2 mm shall be laid on all blinding concrete surfaces with lapping not less than 300 mm for water retaining structures. In general, the cement to be used should be ordinary Portland Cement; however, sulphate resisting Portland Cement shall be used for foundations at locations where soluble sulphate content of ground water is excessive if confirmed by soil investigations. Cast in situ blinding concrete Grade 15, 75 mm thick, shall be provided below all bases and foundations. The structural concrete for all building structures shall be grade 25 (25 N/mm^2).

L2-5.4.3 Reinforcement

Non-pre-stressed reinforcement shall be high strength deformed bars with a specified characteristic strength of 460 N/mm^2 or mild steel bars with a characteristic strength of 250 N/mm^2 .

L2-5.4.4 Structural Design Standards

BS 5950	Structural Steel
BS 5400	Bridges and related structures
BS 8110	Reinforced Concrete Framed building structures
BS 8007	Water retaining structures
BS 8004	Foundations
BS 6399 Part 1	Design loading for building - Live Loads
BS CP 3 Chapter V	Basic data for the design of buildings - Wind Loads
BS 4449	Carbon steel for the reinforcement of the Concrete
BS 4461	Specification for cold worked steel bars for concrete reinforcement

BS 5328 Guide to specifying concrete

The above standards shall be used as applicable; however, other British or other internationally recognized equivalent standards shall be used for specific areas of design.

L2-5.4.5 Pre-stressed Concrete

(i) Concrete

Concrete for pre-stressed pre-cast elements, if required, shall be factory controlled grade 50 concrete (50 N/mm²). Concrete for in-situ post tensioning structures shall be grade 45 concrete (45 N/mm²). Curing of concrete shall be done effectively using methods approved by the Construction Supervision Consultant.

(ii) Reinforcement

Non-pre-stressed reinforcement shall be high strength deformed bars with a specified characteristic strength of 460 N/mm² or mild steel bars with a characteristic strength of 250 N/mm². Pre-stressing steel shall be grade 270, low relaxation strands with an ultimate guaranteed tensile strength of 1860 N/mm². Steel wires for pre-stressed concrete shall conform to requirements of BS 2691. Seven wire strands for pre-stressed concrete shall be stress relieved strands conforming to requirements of BS 3617.

Stressing of wires shall be applied by approved jacking system and suitable allowances shall be made for friction in the jacks and cable ducts.

(iii) Analysis and design

The analysis and design shall be carried out in accordance with the limit state design philosophy of BS 8110 and BS8007.

- (a) The structural designs shall be carried out according to Limit State of Serviceability and Ultimate limit state.
- (b) The partial safety factor for retained water, surcharge and earth pressure shall be 1.4 for most at Ultimate limit state (ULS) and 1.0 at Serviceability limit state (SLS).
- (c) The structures shall be designed with a factor of safety of at least 1.1 against flotation.
- (d) The maximum crack widths shall be:
 - Reinforced concrete – all faces of liquid containing – 0.2 mm max and where aesthetic appearance is critical – 0.1 mm max.
 - Pre-stressed concrete – limited to requirements of BS 8110; however, refer to Section 4.3 of BS 8007 for particular rules for cylindrical tanks.
 - The Cylindrical pre-stressed structures (see section 4.3 of BS 8007), the Tensile stress in the concrete shall be limited in accordance with the recommendations of Section 2.2.3.4.2 of BS 8110: Part 1: 1985. However, it is recommended that pre-stressed, pre-cast elements be designed as class 1 (zero tensile stress).

L2-5.4.6 Structural Analysis and Design Procedures

The analysis and design shall be carried out in accordance with the limit state design philosophy of BS 8110 and BS 8007. The structures shall be checked for compliance with requirements for strength at the ultimate limit state using factored loading with maximum liquid levels. To ensure satisfactory serviceability, the limit states of crack-width and deflection shall then be checked with unfactored loading at normal working levels.

The crack width at the serviceability limit state shall be limited to 0.20mm. For areas where aesthetics are an important factor, the crack width shall be limited to 0.10mm.

Deflections shall be controlled by limiting the allowable span to depth ratio in accordance with the requirements of BS 8110. If pre-stressed / pre-cast elements are needed for any of the structures, these elements shall be designed as class 1 (zero tensile stress) pre-stressed elements for all loading conditions.

L2-5.4.7 Design of Water Retaining and Ancillary Structures

(a) Ground Reservoirs

Ground Reservoirs shall be semi-buried reinforced concrete (RC) or pre-stressed concrete (PSC) structures. The shape of reservoirs shall be determined taking into consideration economic and site factors, and designed as a continuous structure or with full expansion joints at regular intervals to cater for stresses due to temperature variations and long term creep and shrinkage of concrete. As far as possible the use of expansion joints, that in general are potential places for leaks if not treated properly, shall be minimized. RC roof slabs shall be flat slabs supported on columns and freely supported on RC walls. Roof slabs shall be properly isolated and movement joints shall be provided where necessary.

(b) Pumping Stations

Pumping stations using suction pumps shall have floor elevations suitably below the Formation Ground Level (FGL) to satisfy the positive suction criteria. Building plans shall be extended at an elevation above FGL to provide areas for electrical control panels, loading and unloading bays and generator and control facilities. Overhead gantry cranes shall be provided for pump removal and working areas.

Ribbed or corrugated Zn/Al sheet or other approved material on steel lipped C channel purlins shall be used for roofing.

The access door for loading and unloading shall have sufficient width and clear height so that the pumps and / or any other accessories loaded on to a truck can freely move into the loading bay. The clear width shall be not less than 4.0 meters. The clear height shall be such that the pump or other accessories loaded on to the truck can move in with a minimum clearance of 300 mm above the load.

L2-5.4.7.1 General

(a) Concrete Liquid Retaining Structures

Concrete liquid retaining structures shall be designed in accordance with British Code, BS 8007: 1987, and Design of Concrete Structures for Retaining Aqueous Liquids.

(b) Other Concrete Structures

Other concrete structures shall be designed in accordance with BS 8110: Part 1: 1985, Structural Use of Concrete: Code of Practice for Design and Construction. Other equivalent codes or standards may be used as approved by the Employer.

(c) Steel Structures

Steel structures shall be designed in accordance with BS 5950. Other equivalent codes or standards may be used as approved by the Employer.

L2-5.4.8 Design Loads

All loads and load combinations shall be determined as required by the specified codes, occupancy, environmental effects, equipment and processes with the following minimum requirements:

(a) Live Loads

1. Inaccessible roofs	2.5 kN/m ²
2. Roof with mechanical equipment	As per BS 6399 - using actual weights but not less than 7.5 kN/m ²
3. Floor of mechanical rooms	Actual weight but not less than 10 kN/m ²
4. Floors accessible to trucks	Two axles of 9.5 tonnes each, at 1.2m centers with a minimum uniform load of 20 kN/m ²
5. General public access and Personnel Assembly area	5.0 kN/m ²
6. Offices, platforms, walkways	3.0 kN/m ²
7. Electrical rooms	Actual weight but not less than 10 kN/m ²
8. Laboratories and Chemical Rooms and control Rooms	5.0 kN/m ²
9. Storage Rooms	7.5 kN/m ²
10. Plant Rooms	Allow for live loads as appropriate but not less than a minimum super load of 5.0 kN/m ² .
11. Areas subjected to loading by cars	Minimum super loads of 3.0 kN/m ² or minimum wheel load 1300 kg

(b) Overhead Travelling Cranes

All pumping stations and other structures where electrical and mechanical equipments are needed, electrically operated overhead gantry crane of lifting capacity not less than 1.5 times the heaviest equipment shall be provided to facilitate installation and maintenance of the equipment:

- Vertical load impact factor applied to the maximum static wheel load shall be:
 - ☐ Motor driven cranes 1.25
 - ☐ Hand driven cranes 1.10
- Horizontal load acting transverse to the rails as a percentage of the combined weight of the crab, safe working load and lifting appliances shall be:
 - ☐ Motor driven crane 10%
 - ☐ Hand operated crane 5%
- Horizontal loads acting along the rails as a percentage of the static wheel loads shall be:
 - ☐ Motor driven or hand operated cranes 5%

(c) Monorail Support

A monorail shall be provided and installed in buildings and facilities where there is a need to lift and move heavy objects and equipment, whose lifting capacity and the lifting arrangement shall be not less than 1.5 times the static load of the equipment which is expected to be lifted at the installation stage and / or under operational conditions.

Load impact factors applied to the maximum static wheel load shall be:

- ☐ Vertical load impact factor based on hoist capacity: 25%
- ☐ Horizontal load acting longitudinally as a percentage of the static wheel load: 10%

The monorail shall be extended to outside of the building so that it can vertically access the load from a loaded truck parked outside the building. The access door shall have sufficient

width and height so that the monorail can comfortably move the load through the door opening. The clear width of the door opening shall be not less than 1200 mm.

(d) Machinery

Impact factors for machinery supports shall be designed for the manufacturers' recommendations, with the following minimum values:

- Light machinery, shaft or motor drive 20% of operating weight
- Reciprocating machinery or power-driven units 50% of operating weight

(e) Construction Loads

The design load shall accommodate loads from construction activities.

(f) Loads on Buried Reservoir Roofs

Reservoir roofs shall be designed for the weight of saturated earth or 300 mm river pebble that will be placed on the structure plus a live load (minimum of 1.5 kN/m²) based on the use of the area. Consideration should be given to loads from equipment and stockpiling that will occur during the placement of the fill.

- ☐ Wind Loads
 - ☐ Structures shall be designed for a basic wind pressure due to a wind speed Specified in the local guidelines or BS CP 3 –Chapter V.
 - ☐ Wind forces on structures shall be based on the basic wind pressure and modifying factors based on the shape of a structure and its exposure.
- ☐ Process Liquid Loads
- ☐ Lateral Soil and Groundwater Loads
 - ☐ The structures shall be designed for loadings based on the interpretation of the data contained in the geotechnical report for each site, with the following minimum values:

Item No.	Description	Limiting Value
1.	Compacted soil density	20.0 kN/m ²
2.	Active lateral soil pressure coefficient.	0.333
3.	Passive earth pressure coefficient.	3.0
4.	At-rest earth pressure coefficient.	0.50
5.	Lateral surcharge from vehicles	20.0 kN/m ²
6.	Water head at bottom of walls	Groundwater level, if present or as stated below
7.	Density of water	1.0 kg/l
8.	Allowable bearing pressure	Based on soil investigation reports

Structures shall be designed for groundwater at surface level, except for the following conditions:

- ☐ Foundation material is self-draining;
- ☐ Drainage lines are installed around the structure;
- ☐ Walls where vehicles can approach within a distance equal to half the wall height shall be designed for a surcharge of 20kN/m^2 . Consideration shall also be given to any surcharge effects due to adjacent footings or the intended use of the area.

(g) Load Combinations

The Structural Design shall be based on Limit State criteria as stated in BS 8110 and BS 8007. The load combinations shall be as stated in BS 8110 and BS 8007.

The effects of any load type (other than dead load) shall not be used to reduce the effects of another load type. A maximum of 90 percent of the dead load in any combination where it reduces the effects of another load type shall be used.

Structures which contain liquids, extend below grade, or both, shall be designed for the following load combinations:

- Liquid-containing compartments full, with no backfill for liquid containing compartments. No relief shall be given for any passive soil pressure on a structure on the face remote from a contained liquid unless otherwise approved.
- Backfill and groundwater, with liquid-containing compartments empty and full.
- Any liquid-containing compartment empty or full in combination.

(h) Flotation

All structures shall be designed to resist upthrust due to flotation.

(i) Handrail Loads

Handrails shall be designed to withstand whichever of the following live loads produces the most adverse effect:

- ☐ A force of 550 N acting outwards or downwards at any point on the top rail or post.
- ☐ A force of 330 N / m acting outwards or downwards on the top rail.

L2-5.3.2 Architectural /Civil Design

(1) Background

Architectural design of the pump house to be acceptable to the Construction Supervision Consultant. (Building facades overhead travelling crane, beams, etc). Design coordination shall be done with adjacent and below ground structures.

(2) Function and Layout

Preliminary floor plans, sections and elevations for the Pump Houses are indicated in the drawings and the Contractor shall design the building in order to allow proper installation, operation and maintenance of all equipment required and to allow reasonable working conditions for staff and workers in compliance with the laws and regulations in Bangladesh or international standard:

(3) Building Materials and Architectural Finishes

(a) Building Materials

Building shall be of reinforced concrete and masonry brick wall construction where necessary. Appropriate materials shall be used in order to ensure satisfactory aesthetic design and the use of standard products and dimensions and building materials are designed and selected based on the criteria and considerations mentioned in the specifications.

(b) Architectural Finishes

Contractor shall follow the below table for the architectural finishes design wherever necessary.

FINISHING SCHEDULE	
External walls	Two coats of weather shield paint on 200mm block wall with two-way plaster method to achieve a semi rough even finish.
Internal walls	Two coats of emulsion paint on neat fillers on plastered block
Roof	0.47 mm thick Zn/Al roofing sheets with a heat resistant layer, laid to a pitch of 15 degrees on steel frame to be painted with two coats of anticorrosive Zink Phosphate paint and one coat of enamel paint.
Roof gutters	Zn/Al roof gutters with box type down pipes.
Internal ceiling	Plaster board/gypsum ceiling on 600x600 Aluminium framework with no exposed joints.
Internal slab soffits	Two coats of emulsion paint on neat fillers on plastered block wall.
External flat ceiling	Water resistant calcium silicate ceiling board fixed on to the underside of the roof truss.
Eave ceiling	White colour 6mm thick aluminium composite cladding (outdoor type) sheet flat ceiling supported with steel sections fixed on to the underside of the roof truss.
Flat roof	All external R.C.C. slabs and internal toilets to be waterproofed by professional waterproofing contractors.
Floor	Anti slip epoxy self-levelling screed.
Toilet floor	Non slip matt finish 300x600 porcelain tiles.
Toilet wall	300x600 gloss finish five layers of porcelain tiles.
Rest room / Pantry floor	Non slip semigloss finish 300x300 porcelain tiles.
Rest room / Pantry wall	Gloss finish 300x600 porcelain tiles to the height of 450mm above the pantry top.
Skirting	125 mm high skirting of the same floor material of the area either tile or cement
Outside paving around the building	Smooth cement rendering with a slope to the drain

Doors and windows	Gray colour powder coated aluminium doors and double-glazed windows with glass to be specified by the fabricator.
Handrails	Galvanized steel handrails to be painted with primer first and apply two coats of emulsion black colour paint
Roller doors	Galvanized steel roller doors shall be electrically operated with the provision of remote and manually operation.
Drip edge detail.	Refer standard drawings for this detail.
Pantry work top	600 mm x600 mm white colour gloss finish porcelain tiles on R.C.C. concrete work top.
Pantry top cupboards	White colour powder coated aluminium box bars with white colour aluminium cladding sheets and clear glass aluminium framed doors with high grade accessories.
Pantry bottom cupboards	White colour powder coated aluminium box bars and white colour aluminium cladding sheets with high grade accessories.
Mesh for windows.	Stainless steel aviary wire mesh bird-controlled netting in an aluminium frame fixed on to the window internally. This pigeon mesh to be applied for windows using stainless steel wire fixtures.
R.C.C roof canopies with drip edge detail.	Smooth cement rendering to a specified slope for top surface and filler application on fair face concrete to the underside of the canopy.
sky light	8 mm thick flat laminated safety glass sky lights (20nos.) in 600 mmx1200 mm metal frame fixed on to the metal roof sheets as per the sky light specialist's detail.
Ramps	Brush finish hardened concrete floor

(4) Drawings

The following drawings shall be prepared not limited to the architectural design:

- (a) General notes, symbols, abbreviations, floor area and finishing schedule
- (b) Floor plans, sections and elevations
- (c) Standard and special details

L2-5.4.9 Foundations

Design of footings for structures and foundation preparation shall be based on the Contractor's Foundation Specialist's interpretation of the data contained in the reports of the geotechnical investigation for each site and any further geotechnical information obtained from investigations arranged by the Contractor.

(a) Design Specification

Concrete water retaining structures shall be designed in accordance with BS8007 – 1987 British Standard Code of Practice for Design of Concrete Structures for Retaining Aqueous Liquids.

For the purposes of defining the serviceability crack width limit state, the maximum design surface crack width, for direct tension, flexure or restrained temperature and moisture effects shall be 0.2mm, calculated in accordance with Appendices A and B of BS8007.

For ultimate limit state conditions, liquid levels shall be taken to the tops of walls assuming that the liquid outlets are blocked. For serviceability limit state conditions, the liquid level shall be taken to the working top liquid level or the overflow level as appropriate to working conditions.

Testing for watertightness as specified in Section L2-5.6.11 shall be carried out prior to any backfilling around the structures is carried out. Following satisfactory testing and immediately before being brought into use the inside of the structures shall be cleaned and disinfected in a manner approved by the Construction Supervision Consultant.

(b) Technical Requirements.

The concrete grade for water retaining structures shall be 35A with the 28-day characteristic cube strength shall not be less than 35N/mm².

The minimum clear cover to reinforcement shall be

- 50mm on the water face;
- 50mm on the air face;
- 75mm where concrete is deposited against a blinding concrete.
- 75 mm where concrete is deposited against a polyethylene waterproof membrane with a minimum thickness of 0.2mm.

All reinforcement shall be as stipulated in the relevant section of this specification.

Minimum wall thickness shall be 150mm for walls with a single layer of reinforcement except for low walls.

Walls with two layers of reinforcement shall generally be a minimum 250 mm thick. The Contractor shall consider the requirement to insert a concrete vibrator of the diameter not less than 40 mm freely through the reinforcement in deciding the minimum wall thickness.

(c) Joints

Joints in water retaining structure comprise the following:

- Movement joints - Expansion joints
 - Complete contraction joints
 - Partial contraction joints

- Construction joints

The location of joints in the structure and the minimum reinforcement shall be in accordance with Appendix A of BS 8007, which takes into account the effect of joint spacing.

Water-stops shall be located in every construction joint and expansion joint in water retaining structures.

L2-5.5 Specification on Material and Equipment

L2-5.5.1 General

Bidders shall include detailed information on all proposed equipment and materials in their bid. All proposed equipment and materials shall be in accordance with the specifications below or an equivalent international standard.

All miscellaneous equipment and materials not listed hereunder shall be of similarly high quality.

Substitutes proposed by the Contractor for equipment and materials included in the bid must also meet the minimum specifications below and shall not be used without the explicit prior approval of the Construction Supervision Consultant.

L2-5.5.2 Quality of the Workmanship, Materials and Equipment

Equipment shall be compatible with the latest version of BS / BS EN ISO 9000 / ISO 14000 Series Quality Assurance Standards.

L2-5.5.3 Pipes, fittings and installation standards**L2-5.5.3.1 Pipes and Fittings****(a) DI Pipes & Fittings**

The pressure classes of Ductile Iron Pipes and fittings shall be as listed below in accordance with Standard Specification in comply with BS EN545 2010 and for restrained pipes and joints comply with ISO 10804:2018 unless otherwise shown on the Drawings or required for special purposes.

- Socket and Spigot Pipes:
 - DN 80 to DN 300 S / S Pipes (inclusive of both sizes) - C40
 - DN 350 to DN 600 S / S Pipes (inclusive of both sizes) - C30
 - DN 700 to DN 1200 S / S Pipes (inclusive of both sizes) - C25
- Flange Pipes:
 - DN 80 to DN 1200 Flange Pipes (inclusive of both sizes) - PN16
- Restrained Pipes:
 - DN 80 to DN 1200 Flange Pipes (inclusive of both sizes) - PN25
- Restrained Fittings:
 - DN 80 to DN 1200 (inclusive of both sizes) - PN25
- Standard Ductile Iron Flanged Straight Pipe Fittings of Standard lengths (e.g., 300mm, 500mm, 800mm, 1000mm etc.), and Straight Pipe Fittings with Puddle or Thrust Flanges, shall be of PN16 Integrally Cast.
- Ductile Iron Straight Flanged Pipe and long Pipes for Crossings shall be Class C30 (for diameters from DN 400 to DN 600 both sizes inclusive) and Class C25 (for diameters from DN 700 to DN 1200 both sizes inclusive) Centrifugally Cast Pipes with Factory-Welded Flanges.
- Ductile Iron Fittings and Valves, housed within Chambers, shall be Epoxy Coated.
- Flange Adaptors and Couplings shall be to suit Ductile Iron Pipe, and incorporate EPDM gaskets. Couplings shall be VJ-type, or similar. For the Butterfly Valve Chambers, the Contractor shall ensure that the type of Flange Adaptors used are suitable for installation with Butterfly Valves and do not interfere with the Valve operation.

- **Restrained Joints:**

The design of Restrained Joints shall comply with ISO 10804:2018 or equivalent. The joint shall be externally restrained.

The spigot of the restrained joint pipes shall be compatible, with or without modification at Site, with the standard and restrained joint fittings.

Restrained joints shall be designed by the Pipe Manufacturer to transmit axial Pipe to Pipe forces generated due to change in direction of the pipeline and possible pipeline settlement in weak soil areas without thrust blocks. Rubber gaskets shall be of EPDM. Locking ring and bolts shall be of ductile iron.

Where on-site bead welding becomes necessary due to Site condition, such bead welding shall be as recommended by the Pipe Manufacturer and comply with the following minimum specification and procedure:

- i) **Surface Preparation**

- The bead position shall be marked using an appropriate guide (preferably copper guide) complying with the required dimension from the Pipe end.
- The surface to be welded shall be prepared by lightly grinding (without affecting Pipe thickness) to remove all coatings. The width of ground surface shall not be more than 50mm.

- ii) **Positioning and Welding**

- The guide shall be positioned before the weld complying with the required dimension from the Pipe end.
- The locking bead shall be deposited against the guide and weld to obtain a flat vertical face at right angle to the Pipe surface. The number of passes of welding shall be minimum of two (2) for Pipes of diameter greater than 600mm while one (1) pass for diameter 600mm and less.
- The weld bead dimension shall be as per the Manufacturer's recommendation and shall not be less than the standard bead dimensions.

- iii) **Repair of External Coating after Welding**

- the welded area shall be wire brushed, cleaned and then Manufacturer recommended paint shall be applied in accordance with their external coating guides.

- iv) **Welding Equipment Requirement**

- The electric welding machine used for welding shall be with a minimum capacity of 150 amperes
- The electrodes shall be of Ferro-nickel electrodes of not less than 3mm diameter solid wire according to ISO 1071

- v) **Testing of Weld Bead**

- The first weld bead shall be tested with DPT (Die penetration Test). Jointing is allowed only if the DPT is passed.
- At least 25% of randomly selected weld beads shall be tested with DPT.

- vi) **Arrangement for Weld Bead Fabrication**

- The welding shall be carried out under a shelter by professional welders who

possess valid certificate for DI welding.

- **Polyethylene Sleeving:**

Where specified Tubular polyethylene (LPDE) protective sleeving for buried DI pipes & fittings shall comply with the relevant provisions of BS 6076: 1996 and shall be in accordance with ISO 8180: 2020. Further it is preferable to supply the sleeving by the Manufacturer of the ductile iron Pipes.

The Polythene Sleeving shall not be provided for Restrained Pipe sections which have been provided to resist the axial forces (such as for bends and either side of marshy area crossings etc.,)

The Tubular Sleeve shall be slipped over and snugly fitted to the Pipe by means of adhesive plastic tape at each end as recommended and care shall be taken to avoid the ingress of water, soils or any foreign particle into the pipe barrel. The Contractor shall submit and obtain the Construction Supervision Consultant's approval for the Method Statement explaining the technique inserting, joining etc., prepared based on the Manufacturer's recommendations.

(b) HDPE Pipes and Fittings

The HDPE Pipes and fittings shall be manufactured of blue colour compounds and shall be straight Pipes 12m long.

As shown in the Drawings, the Minimum Required Strength (MRS) designation for Materials of all HDPE Pipes and fittings for the permanent Works shall be PE100 polyethylene to EN 12201. The nominal pressure rating for HDPE Pipes and fittings shall be PN16 for Primary, Secondary and Tertiary Mains unless shown otherwise. All HDPE Pipes and fittings shall be suitable for and be joined by Butt-Fusion Welding.

- HDPE flanged stub connector fittings, for connection of HDPE Pipe to a DI flanged end, shall always include the appropriately sized stainless steel backing ring to be supplied by the same manufacturer as the HDPE flanged stub connector, and with bolts, nuts and washers. The Flanges of HDPE fittings (such as Stub Flange) shall be integrally cast.
- The Manufacturer shall submit a product conformity certificate for Pipes & Fittings conform to the EN 12201 standard and Water Regulations Advisory Scheme (WRAS) approval to ensure the safety of the potable water in the pipeline.
- The Manufacturer shall submit authenticated Type Test Certificates for long term hydrostatic test conducted as per ISO 1167.
- The Contractor shall be solely responsible for ensuring that flotation of HDPE Pipework does not occur during Construction.
- Butt-fusion welded Pipes and fittings and electrofusion welded fittings must be installed by qualified individuals trained and certified in butt-welding and electrofusion installation procedures.

L2-5.5.4 Service Connections

(a) Electrofusion Fittings:

All the electrofusion fittings included shall be designed for use in water distribution systems and be manufactured / supplied by manufacturers having ISO 9001: 2000 certification for their quality systems. The products shall comply with the following specific requirements.

- The products shall comply with the requirements of BS EN 12201-3: 2003, BS EN 1555-3 or ISO 8085-3.



- All the fittings shall be of SDR 11 rating.
- The EF Tapping Saddles/Fittings used for drinking water applications shall have the WRAS approval.
- EF Tapping Saddle / Fittings to be manufactured by injection moulding using virgin compounded PE 100 Black polymer sourced by a raw material manufacturer approved by PE100+ association and should comply with the requirements of BS 3412 and/or BS EN 12201-1.
- The Electrofusion Tapping Saddles/Fittings intended for water distribution applications shall be coloured black for the clear identification of the services.
- The EF tapping saddles/tees shall have in built Brass composite cutter cum flow regulator with cutting edges to cut the pipe for making suitable bore for HSC tapping.
- The branch connection of the tapping saddle shall be designed to allow rotation, providing flexibility to suit different installation locations. This rotation capability enables the branch connection to be aligned conveniently with the desired orientation, ensuring optimal positioning before the electrofusion welding process takes place. The Electrofusion Tapping Saddles shall NOT be the WRAP AROUND type.
- No heating element shall be exposed and all coils are to be integral part of the body of the fitting. The insertion of the heating element in the fitting should be part of the injection moulding process and coils inserted after the injection moulding process or attached to the body of the fitting as a separate embedded pad etc. are strictly not acceptable.
- The brand name, size, raw material grade, SDR rating and batch identification are to be embedded as part of the injection moulding process. Each fitting should also be supplied with a barcode sticker for fusion parameters attached to the body for setting the fusion parameters on an automatic fusion control box. The barcode sticker should also include the fusion and cooling time applicable for the fitting for the manual setting of a manual fusion control box.
- The cutter should be designed in such a way that the cut coupon is not allowed to fall into the pipeline and is retained inside the body of the cutter providing a positive sealing of the hole in the cutter head for pressure testing.

(b) Connection Pipe:

High-Density Polyethylene (HDPE) Pipes shall be according to ISO 4427-1:2007 and ISO 4427-2:2007 and shall be suitable and approved for use with potable water at a working pressure of at least PN 10 bar. Refer the standard drawing of house connection for details.

(c) Push-fit Male Threaded Adapter:

The Push-fit Male Threaded Adapter shall be suitable for permanent installation in a chlorinated potable water HDPE pipe system with a male thread at one end for connection to the Lockable Valve and a push-fit connector at the other end for insertion of a square-cut HDPE pipe. Once fitted the adapter shall provide a permanently watertight seal and shall be impossible to detach from the HDPE pipe without cutting the pipe. The push-fit design shall allow the adapter to be installed without the need for additional tools or fittings. The adapter shall have a pressure rating of PN 16 and shall be constructed from durable parts made from

non-toxic corrosion resistant metal alloys such as gunmetal, bronze, stainless steel or as approved by the Construction Supervision Consultant.

(d) Lockable Valve:

The Lockable Valve shall be a straight quarter-turn ball valve specifically designed to pass or block the flow of chlorinated cold potable water to a connected meter and to be locked in either the open or closed position by CWASA by means of sealing wire. The valve shall have a female thread at one end for connection to the Push-fit Male Threaded Adapter and a male thread at the other end for easy connection to a water meter. The fully open flow passage shall be straight, circular and unobstructed and the fully closed. Ball shall be watertight up to the maximum pressure rating. The valve shall have a pressure rating of PN 16 and shall be constructed from durable parts made from non-toxic corrosion resistant metal alloys such as gunmetal, bronze, stainless steel or as approved by the Construction Supervision Consultant.

(e) Non Return Valve:

The Non-Return Valve shall be spring-loaded to allows one-way flow of water and prevent backflow. The threaded connections enable easy installation, The valve shall have a pressure rating of PN 16 and shall be constructed from durable parts made from non-toxic corrosion resistant metal alloys such as gunmetal, bronze, stainless steel or as approved by the Construction Supervision Consultant.

(f) Double male-threaded Nipple and Customer Meter:

To be supplied and installed by the CWSIP/G3 Contractor.

(g) Connection Pipe downstream to the meter:

Pipe shall be laid in the same material as the Connection Pipe and all fittings shall be HDPE and suitable for electrofusion or butt fusion welding

L2-5.5.5 Appurtenances and Pipe Saddles

(a) Valves, Surface Boxes and Manhole Covers

- All Butterfly Valves of DN 350 and above shall be provided with gearing arrangement
- All gate Valves and butterfly Valves shall be epoxy coated
- The Float Ball Seats of Air Valves shall be of robust and reliable quality, with heavy duty ball seals to suit high pressures.
- The Contractor shall supply the following additional Materials for use of the Employer as replacement parts for the Valves furnished under this Contract, in quantities of:
 - i) For every five (5) Gate Valves of the same size and type or fraction thereof:
 - 1 Set Stem Seal
 - 1 Pc Gasket with O-Ring seals
 - 1 Pc Bonnet Gasket
 - 1 Pc Stem
 - 1 Pc Operating Nut
 - ii) For every five (5) Butterfly Valves of the same size and type or fraction thereof:
 - 1 Pc Shaft Seal

- 1 Pc Rubber-Sealing Ring
- 1 Pc Thrust Bearing
- 1 Pc Operating Nut
- iii) For every five (5) fire hydrants of the same size and type or fraction thereof:
 - 1 Pc Shaft Seal
 - 1 Pc Rubber-Sealing Ring
 - 1 Pc Thrust Bearing
 - 1 Pc Operating Nut
 - 1 Pc Outlet Stand-Pipe (1m high)
- iv) When each type of Valve to be installed is less than five (5) Sets, each one (1) set of the Materials specified above shall be provided.
- v) Spare parts shall be provided for every 5 non-return Valves, or a fraction thereof, including spare hinge pin, and every 5 air Valves, or a fraction thereof, including float seals.
- vi) In addition to the above, for all types of Valves, the Contractor shall provide spare parts as recommended by the manufacturer.
 - All Tee-Key operated Valves shall be provided and fixed with Valve Spindle Caps as per BS 5163:1986.
 - Four (4) Tee-Keys for each size of Valves shall be supplied.
 - The Contractor shall supply two complete sets of tools adequate for the erection and maintenance of all Valves, hydrants and other fittings supplied.
 - Costs of these Maintenance Materials & Tools shall be deemed to be included in the rate of each type of Valve.
 - In compliance with the CWASA valve quality standards

(b) Pipe Saddles for rigid pipes

- Pipe saddles for rigid pipes shall comply with the water utility quality standards. In the case of missing standards, the following guidelines apply:
 - i) Pipe saddles shall be of the universal type with flexible strap for DI, steel and AC pipes and shall be suitable and approved for use with potable water at a nominal working pressure of 16 bar.
 - ii) The body of the pipe saddle shall be of ductile iron EN-GJS-400-18 acc. to EN 1563 (GGG 400 DIN 1693), and shall be epoxy powder coated with a minimum coating thickness (DFT) of 250 µm in accordance to DIN 30677-2 and DIN 3476, inside and outside.
 - iii) Saddle strap and bolts / nuts / washers shall be made of stainless steel 304. Strap shall be rubber lined to avoid direct contact between the stainless-steel strap and the pipe. Gaskets shall be of EPDM or NBR (suitable and approved for potable water).

(c) Pipe saddles for plastic pipes



- Pipe saddles for HDPE pipes shall comply with the water utility quality standards design for electro fusion welding.

(d) Pipeline Marker Tape

- For all buried HDPE Pipelines, detectable-type luminous blue colour Marker Tape, which can be detected by underground Pipe locator operating by induced magnetic field, shall be installed 300mm above the Pipe.
- The Contractor shall ensure the connectivity of magnetic field at the joints of detectable tape. The Manufacturer shall provide necessary joining facility to maintain the conductivity.
- For all buried DI Pipelines, non-detectable-type luminous blue colour Marker / warning Tape shall be installed 300mm above the crown of the Pipe.
- Both the detectable and non-detectable marker tapes shall comply with Standard Specification.

(e) Surface Boxes & Manhole Covers

- Manhole Cover and frames and Surface Boxes shall have cast in-letters of Words in English to indicate the function of the fittings "FH, WO, SV, BV, PRV, METER" and "CWASA – WATER" in size as Specified, cast-in raised letters.
- Manhole Covers and Frames shall be equipped with Captive Hinge arrangement to deter vandals and with suitable Watertight arrangement to prevent ingress of surface water into the Manhole and shall be Non-Rock and Black Bitumen coated.
- The Manhole Covers shall be of following Types:
 - i) • For Air Valves – Ventilated Type
 - ii) • For Gate Valves and Butterfly Valves – Watertight-type
 - iii) • For Flowmeters and flow control Valves – Watertight-type
- The Contractor shall supply 10 nos. of lifting keys suitable for each type of manhole cover and surface box and costs of these keys shall be deemed to be included in the rates manhole covers and surface boxes.

L2-5.6 Specification on pipe works

The following standards are referred to:

ISO 4482	Asbestos-Cement Coating - Guide for laying
AWWA C203	Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape-Hot-Applied
AWWA C206	Field Welding of Steel Water Pipe Joints
AWWA C210	Coal-Tar Epoxy Coating System for the Interior and Exterior of Steel Water Pipe
AWWA C600	Standard specifications for the Installation of Gray and Ductile Cast-Iron Water Mains and Appurtenances
AWWA C601	Standard for Disinfecting Water Mains
AWWA C603	Standard Specification for the Installation of Asbestos-Cement Pressure Pipe
AWWA C605	Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings
AWWA Manual M11	Steel Pipe Design and Installation

L2-5.6.1 General

It is expected that all installations shall comply with the current applicable specifications - Employer's standard specifications. Wherever no specific works and installation specifications are available, the following general specifications shall apply.

- a) Contract Health and Safety Standards shall be implemented at all constructions and installation stages.
- b) The Contractor shall execute all works in accordance with international best practice and with all relevant regulations and norms of the country.
- c) The Contractor shall take digital photos showing BEFORE-AFTER effect at all stages of the work progress according to instructions given by the Construction Supervision Consultant.
- d) All old pipes, valves and other appurtenances shall be returned to the Employer unless otherwise instructed by the Construction Supervision Consultant.

L2-5.6.2 Pipeline Trenches

All the work shall be carried out in accordance with the relevant current specifications and drawings unless specified, and to satisfaction of the Construction Supervision Consultant.

L2-5.6.3 Reinstatement of Surfaces

Temporary and permanent Reinstatement shall be carried out in accordance with the latest specifications and requirements of the Construction Supervision Consultant and the competent authorities.

L2-5.6.4 Topographical Survey Works by the Contractor for Pipelines

The Contractor shall engage a Licensed Surveyor to conduct detailed topographical surveys along all pipeline routes including but not limited to longitudinal surveys along and across

public and private roads and railway lines and through public and private land, across rivers and water bodies and under and over bridges and embankments and shall comply with but not be limited to the following requirements:

- (1) All measurements and results of the survey shall be taken and shown in S.I. units.
- (2) The Contractor shall establish clearly identified and immovable Temporary Benchmarks at convenient locations within the project area with an accuracy of within $\pm 2.5\text{mm}$ in plan and elevation using closed total station or equivalent land surveying instrument surveys to facilitate checking.
- (3) The provision of all survey equipment, personnel, transportation and others required to complete the Survey Works shall be at the Contractor's expense and is deemed to be included in the rates for the respective items.
- (4) The Contractor shall commence the Survey Works in the field within 2 weeks after receiving a written Notice to Proceed from the Construction Supervision Consultant.
- (5) The required survey accuracy shall be as directed by the Construction Supervision Consultant but in any case shall be within $\pm 5\text{mm}$ in elevation and plan unless the Construction Supervision agrees to greater tolerances due to exceptional local conditions.
- (6) Surveys using GPS equipment shall be validated at the Contractor's expense by closed total station measurements for an initial representative 15% sample of recognisable point locations selected and validated by the Construction Supervision Consultant. If more than 5% of the sample points contravene the accuracy limits set by the Construction Supervision Consultant or if the accuracy of any single point exceeds twice those accuracy limits then the entire GPS survey shall be repeated at the Contractor's expense until compliance is achieved.
- (7) The Contractor shall submit all survey drawings to the Construction Supervision Consultant for checking, review and comment as two original prints on white paper and in a digital format to be agreed with the Construction Supervision Consultant, such as AutoCAD or PDF.
- (8) Any comments, corrections and queries regarding a survey drawing signalled to the Contractor by the Contract Supervision Consultant shall be recorded by the Contractor as a separate layer on the corresponding drawing, diligently followed up and the drawing amended, corrected or explained by the Contractor on the drawing before resubmission to the Construction Supervision Consultant within two weeks after receiving them.
- (9) The Contractor shall prepare and submit final survey drawings accepted by the Construction Supervision Consultant without comment as two original prints on white paper and as digital copies in the agreed format with the date of the Construction Supervision Consultant's acceptance marked.

L2-5.6.5 Identification and Isolation of unidentified Pipelines Crossing at DMA Boundaries

A fundamental characteristic of DMAs is that they be hydraulically isolated from the rest of the water distribution network except at metered inlets and outlets. This isolation is established and verified by Zero Pressure Tests (ZPTs), in which the metered inlet and outlets are also closed to cut off the supply to the DMA, momentarily eradicating the supply pressure within the DMA. Each DMA is designed based on the known features of the network, with

valves situated on pipes crossing the DMA boundary to isolate it from the rest of the system. Imperfect knowledge of the distribution system, which in many places is very old, may mean that Unknown Pipes crossing the DMA boundary continue to feed the DMA and the ZPT is unsuccessful. To ensure the effectiveness of the ZPT, it is recommended to follow a standard measurement protocol. **A minimum of three pressure loggers shall be installed inside the DMA** at hydraulically critical points — typically at the farthest node, a high elevation point, and a low point. In addition, **at least one pressure logger shall be installed just outside the DMA**, near the closed boundary valve, to monitor any external pressure influence. **Pressure logging shall start at least 30 minutes prior to valve closure and continue for a minimum of 60 minutes thereafter.** The sampling frequency shall be at least 1 Hz, and test validity requires that all customer connections within the DMA remain closed during the test. The ZPT shall be deemed successful if the internal pressure remains consistently below 0.5 mWC for a period of at least 30 continuous minutes, indicating that there are no inflows from unknown or unclosed connections. Tests should preferably be conducted during off-peak hours to minimize external disturbances and water usage within the DMA.

In the event of an unsuccessful ZPT the Contractor shall conduct tests to identify the section(s) of the DMA with connection to the surrounding network and then thoroughly investigate potential crossing points to locate the pipe(s) that remain to be closed to ensure complete DMA isolation using non-intrusive methods wherever possible and test pits and trenches if these prove to be ineffective. The cost of these investigations to locate Unknown Pipes is deemed to be included in the Contractor's rates and prices for DMA Establishment.

Once identified then the Contractor shall use pipe tracing, test pits and such other means as may be necessary to obtain the characteristics of the Unknown Pipe (material, diameter, alignment, connection points to the known network, valves, hydrants, connected customers, etc.) and add it to the hydraulic model. The Contractor shall then use the hydraulic model to inform a proposal to the Construction Supervision Consultant to either:

- A) abandon the Unknown Pipe altogether by permanently disconnecting it from the network
- B) break the cross-connection by cutting and capping the Unknown Pipe on both sides of the DMA boundary
- C) close the Unknown Pipe by installing a Boundary Valve, to be kept shut except in the event of an emergency or a revision of the DMA boundary.

The Contractor's proposal shall include full survey details of the Unknown Pipe and outline design drawings for the works proposed to close the DMA boundary, showing the location of each item of the work, the locations of any other services in the vicinity of the proposed works as well as the works themselves, a costed breakdown of the proposed works and a work programme that includes traffic management and alternative supply arrangements for customers affected by any supply interruptions that may be required.

The Contractor shall discuss and incorporate any design changes required by the Construction Supervision Consultant into a DMA Boundary Closure Final Design Proposal that shall be submitted in two copies to the Construction Supervision Consultant for approval, who will return a dated and stamped Approved copy to the Contractor, who shall then proceed with the Approved Works.

The Contractor shall take all necessary measures and care to prevent damage to any of those Water Pipelines or other utility Pipelines or any other underground utilities found during excavation or afterwards. Any additional cost due to such damages over and above the quoted isolation cost shall be the responsibility of the Contractor.

It shall be the responsibility of the Contractor to verify whether the Pipelines found are live Water Pipelines, as there could be abandoned pipelines, telecom or electricity encasement Pipes. The Contractor shall indemnify and hold the Employer harmless against and from the consequences of any form of damages, losses and expenses resulting from any damages caused to such telecom, electricity or other utilities.

The Contractor shall require close liaison with the CWASA Area Engineer, the Construction Supervision Consultant and / OIC / Zone Officers of the CWASA MOD during the complete process in order to facilitate smooth and trouble-free Work.

All such excavations shall be performed and reinstated as specified elsewhere and to the satisfaction of the relevant authority.

L2-5.6.6 Horizontal Direct Drilling

Contractor shall be fully responsible for carrying out all investigations, providing and operating all necessary machinery and equipment, engaging qualified and skilled design and operating personnel, supplying and installing all pipes and fittings and for the monitoring and testing of the Work to ensure that any Pipe installed by HDD shall comply with the requirements of this contract. Contractor's responsibilities shall include but not be limited to:

- a. Locate utilities and any other underground infrastructure that could be impacted or disturbed by HDD work in the vicinity of a proposed Pipe and design the Pipe alignment to avoid them
- b. Perform geotechnical investigations as necessary to design and drill the Pipe without interference
- c. Finalize the Pipe alignment considering the above investigations
- d. Incorporate site planning and traffic management in the HDD work plan
- e. Design and construct Entry and Receiving Pits for HDD works
- f. Select, provide and operate all necessary machinery and equipment for HDD Pipe installation and automatic data logging
- g. Remove and immediately dispose of spoil material
- h. Perform and record any and all topographic surveys required to establish the Pipe alignment, manhole locations, pit locations, invert levels, guidance system for HDD Pipe installation, etc.
- i. Supply and install all pipes and fittings for construction of the Pipe
- j. Monitor the surfaces above the Pipe alignment and adjacent structures to record any movement associated with or subsequent to HDD installation of the Pipe and restore or mitigate any adverse impacts due to settlement or expansion of the surrounding ground
- k. Perform such other associated activities as may be necessary including but not limited to Site restoration and coordination with other Work items.

Contractor shall prepare and submit a fully detailed method statement and work plan with relevant permissions and other documents for the Construction Supervision Consultant's Approval before starting any HDD works.

L2-5.6.7 Bulk Flow Meter Chambers

- a. All bulk flow meters shall be installed in a chamber large enough for maintenance, dismantling, removal and replacement of the meter and the associated pressure transducers, manifolds, water quality monitors, power supplies and data capture and transmission equipment to be supplied and installed by the CWSIP/G3 Contractor.
- b. Bulk flow meter chamber covers, and cover frames shall be lockable and large enough to allow for easy insertion, support and removal of the meter and associated fittings and

shall be designed such that no part of the cover can accidentally fall through the frame and impact a person in the chamber or the meter itself.

- c. Bulk flow meter chambers and covers in roads and other areas subject to vehicular traffic or parking shall be designed and constructed to support maximum allowable wheel loads without settlement and the chamber covers and frames shall be non-rocking and adjustable to sit flush with the road surface. Covers and frames shall be cast from Ductile Iron with "CWASA" and "meter" embossed into the top of the cover. The cover and frame shall be close-fitting when closed to prevent the ingress of water, dirt, insects and vermin.
- d. Bulk flow meter chambers and covers in paved areas not subject to vehicular traffic shall be designed and constructed to support the weight of pedestrians, light vehicles and the plant, tools and lifting equipment that may be required to install, maintain or remove the meter and its associated fittings without settlement and the chamber covers and frames shall be non-rocking and adjustable to sit flush with the paved surface. Covers and frames shall be manufactured from hot-dip galvanised mild steel or cast from Ductile Iron, with "CWASA" and "meter" embossed into the top of the cover. The cover and frame shall be close-fitting when closed to prevent the ingress of water, dirt, insects and vermin.
- e. Bulk flow meter chambers and covers in unpaved areas shall be designed and constructed to support the weight of pedestrians, light vehicles and the plant, tools and lifting equipment that may be required to install, maintain or remove the meter and its associated fittings without settlement. The chamber walls shall be constructed to protrude above the surrounding natural ground by at least 0.6m. The chamber covers and frames shall be manufactured from hot-dip galvanised mild steel or cast from Ductile Iron, with "CWASA" and "meter" embossed into the top of the cover. The cover and frame shall be close-fitting when closed to prevent the ingress of water, dirt, insects and vermin.
- f. Detailed specifications and examples of the Contractor's proposed chamber covers and frames shall be submitted to the Construction Supervision Consultant for approval before delivery and only approved covers and frames shall be installed.
- g. Bulk flow meter chambers shall be located such that the meter manufacturer's recommended lengths of straight pipe with the same nominal internal diameter as the meter itself shall be installed upstream and downstream of the meter. The pipes passing through the chamber wall shall be epoxy coated double flanged straight pipes with a puddle flange cast into the wall itself. The Contractor shall construct the chamber with a spool piece provided by the CWSIP/G3 Contractor installed in place of the meter itself together with any earthing rings or other fittings that the CWSIP/G3 Contractor intends to install. A minimum of the first 1m length of pipe outside the chamber wall shall be an epoxy coated plain ended straight pipe connected to the cast-in flanged pipe protruding from the wall with a flexible coupling to allow for possible differential movement of the meter chamber and the incoming and outgoing pipelines.
- h. The Contractor shall supply and install a robust, secure, shaded and ventilated weatherproof and insect proof lockable instrument pillar as close as possible to and not more than 15m from the nearest wall of each bulk meter chamber to house any above-ground components to be installed by the CWSIP/G3 Contractor. Three underground waterproof flexible stainless steel ducts of at least 80mm diameter with at least 3 pull-through cords in each shall be installed at a minimum of 500mm below the ground surface to connect the interior of the base of the instrument pillar to the interior of the

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bulk meter chamber and shall protrude at least 500mm into the instrument pillar and bulk meter chamber at each end for the CWSIP/G3 Contractor to separately install electric power cables, instrument cables and water lines. The design and construction of the instrument pillar shall be finalised in consultation with the CWSIP/G3 Contractor and submitted to the Construction Supervision Consultant for approval before being manufactured according to the approved design and installed. As an indication only, each pillar is likely to have an internal cross section of approximately 0.2 m^2 , a height of approximately 1.7m, a usable internal volume of approximately 0.25 m^3 and a hinged door measuring approximately 0.3m wide and 0.9m tall.

- i. The bulk meter chamber floor shall be benched to drain any water to a 0.3m diameter pump sump 0.5m deep cast into the chamber floor directly below the chamber cover. The chamber floor shall be at least 0.5m below the underside of the pipe and, pipe diameter permitting, no more than 1.3m below the top of the pipe to facilitate meter installation and maintenance. The chamber width shall provide a minimum of 0.4m of working space on each side of the pipe flanges. A stainless-steel vertical step ladder shall be fixed to the chamber wall below the chamber cover to provide safe descent to the chamber floor, while providing sufficient clearance through the cover for the meter and any associated fittings to be lowered into or hoisted from the chamber.

L2-5.6.8 Testing and Disinfection

L2-5.6.8.1 General

(1) Scope of Work

The Contractor shall furnish all labour, equipment, materials and measurement devices required for the pressure and leakage testing and the disinfection of the finished pipelines. The finished pipeline includes the pipes, fittings, valves, fire hydrants and all other appurtenances that are constructed under this Contract. The Contractor shall provide the facilities necessary to convey the water from its sources, as designated by the Construction Supervision Consultant, to the place where it is required, and shall install the measurement devices.

All testing and disinfecting operations shall be done in the presence of the Construction Supervision Consultant.

Late delivery of valves shall not delay testing and commissioning of a pipeline. In such cases the Contractor shall supply and install spool or make up pieces so that testing may proceed. The Contractor shall install valves later in a manner acceptable to the Construction Supervision Consultant.

(2) Standard Specification References

The following standard are referred to

AWWA C600	Standard for Installation of Ductile-Iron Water Mains and their Appurtenances
AWWA C601	Standard for Disinfecting Water Mains

(3) Submittals

The Contractor shall submit to the Construction Supervision Consultant a sketch for each section of pipe to be tested as part of his shop drawings, showing the section schematically in profile with the point of filling, point of pressure observation and test pressure and the sequence of operations to be followed during the test, such as observations and closing of air valves, blow-offs and other appurtenances, as directed by the Construction Supervision Consultant.

L2-5.6.8.2 Colouring Tests for Welding

The colouring test shall be performed at each welding joint on the entire length of the joint. In the event that defects or incompleteness are revealed then the weld shall be inspected in accordance with JIS Z2343. When any defect or pin hole is detected by the colouring test, the Contractor shall repair it to the satisfaction of the Construction Supervision Consultant and shall repeat the colouring test to confirm that the weld has been repaired satisfactorily.

All such tests shall be carried out by the Contractor in the presence of the Construction Supervision Consultant. Where necessary, welds shall be repaired in accordance with instructions of the Construction Supervision Consultant.

The Contractor shall nominate a qualified chief supervisor who shall be responsible for performing and supervising the field tests of steel pipes.

L2-5.6.8.3 Field Hydrostatic Pressure Test**Inspection**

If stipulated by the Employer, all materials are subject to inspection and approval at the manufacturer's plant.

Inspection on Delivery

All pipe and appurtenances are subject to inspection on delivery. Neither the inspection nor absence of inspection shall relieve the manufacturer of its responsibility to provide materials meeting the requirements of the Contract Documents. Materials not conforming to the requirements of this Specification shall be made satisfactory or replaced. Pipes or appurtenances that fail to comply with specified tests shall be made satisfactory or replaced.

Workmanship

All pipe and appurtenances shall be tested under pressure for defects and leaks in accordance with this Specification.

Hydrostatic Testing

The testing methods described in this Specification are specific for water- pressure testing only.

The Contractor shall submit a comprehensive method statement for the hydrostatic testing of pipelines to the Construction Supervision Consultant for approval before any testing shall commence, including design of thrust blocks or temporary anchorages, method of supply of water, method of detecting and repairing leaks, details of test equipment and detailed work program.

The Contractor shall provide all plant, equipment, material and labour necessary for carrying out the hydrostatic tests including water, pumps, compressors, gauges, pipe connections, stop ends, and all other temporary works such as thrust blocks or bulkheads etc. and shall arrange for all tests to be approved beforehand and witnessed by the Construction Supervision Consultant, who shall be notified at least one working day before the start of the test.

For purpose of interim testing, the pipeline shall be divided into sections. Each section shall be separately tested to the Construction Supervision Consultant's satisfaction for hydrostatic pressure when each section is completed. The length of pipeline to be tested shall not be less than 500m nor greater 1 km in any one test without the explicit prior written approval of the Construction Supervision Engineer and no test shall commence until at least ten days after thrust blocks and other holding down works have been completed. Pipelines intended for buried service shall generally be tested with the backfill in place. No fluid other than

chlorinated potable water shall be used for hydrostatic pressure testing and compressed air or gas specifically shall not be used for any purpose under any circumstances because of the serious safety hazards involved.

Procedures for performing hydrostatic pressure tests for each section of pipeline shall include;

- Location and capacity of the test pump
- Determination of the test pressures at the pump and at the high and low points in the pipeline
- Procedures for venting all air from the pipeline
- Procurement and conveyance of the water to fill the pipe for testing
- Draining and disposing of the test water after satisfactory completion of the test.

The Contractor shall be responsible for the care of the works during testing of the pipework. The Contractor shall note that neither the satisfactory testing of a pipeline, section of a pipeline or any other pipe work, nor the acceptance of the testing by the Construction Supervision Consultant or his representative shall in any way relieve the Contractor of any of his responsibilities and obligations under the Contract.

Test Restrictions of Hydrostatic Pressure Test

The Contractor shall have the gauges to be used for pressure testing of pipelines calibrated at a qualified testing laboratory, including one gauge to be handed over to the Construction Supervision Consultant for the purposes of verification during testing, and a certificate of their accuracy submitted to the Construction Supervision Consultant for approval, before testing commences and then at regular time intervals thereafter as required by the Construction Supervision Consultant, who shall determine the number of pressure gauges to be calibrated according to the frequency of the planned hydrostatic pressure tests.

The pressures generated in the test section of the pipeline by the piezometric head specified for each test shall not exceed the thrust restraint design pressure or 1.5 times the manufacturer's specified pressure rating of any pipe or joint, whichever is the lesser, but otherwise shall be equivalent to whichever is the greatest of:

- 1.25 times the design working pressure at the highest elevation of the test section,
- the maximum surge pressure at the highest elevation of the test section,
- 1.5 times the design working pressure at the lowest elevation of the test section.

The hydrostatic test pressure shall be sustained for at least 2 hours and then a piezometric head equivalent to the working pressure shall be sustained for at least a further 24 hours or as specified by the Construction Supervision Consultant.

The open ends of the test section of pipeline shall be stopped off by blank flanges, or end-caps, secured where necessary by temporary struts and wedges, not by valves, which cannot be guaranteed to be perfectly drop-tight, unless with the written approval of the Construction Supervision Consultant. In any event, no valve shall be operated in either direction at a differential pressure exceeding the rated valve working pressure. If permanent air vents are not located at all high points, the Contractor shall install corporation cocks at such points so that all air can be expelled as the line is filled with water. The use of corporation cocks above rated pressure must be at the Contractor's risk and authorized specifically by the manufacturer.

The Contractor shall provide Stop Ends at end points of the test section of the pipeline for the purposes of injecting, draining and pressurising the volume of water required to fill the pipeline completely and sustain the required pressures for the duration of the test. Stop Ends

shall consist of a section of steel pipe about 0.5-1.0m long onto which a closing plate has been welded, equipped with suitably terminated connectors for passing water and air, joined to the pipe to be tested by means of a standard coupling or other method approved by the Construction Supervision Consultant. Thrust blocks or temporary anchorages shall be provided to hold the Stop End in place against the test pressure. The Contractor may also use proprietary restrained joints in lieu of thrust block.

Each test section of pipeline shall be filled with water while air is allowed to be released from the highest points of the pipeline. The pipeline fill rate shall be controlled such that flow velocities during filling do not exceed the design velocity of the piping system or the capacities of the air release devices or other openings used to evacuate the entrapped and avoid or limit transient pressure surges when the water reaches the air venting openings. Once completely filled the pipeline shall be left to settle under light pressure for enough time to allow dissolved and entrained air to accumulate at the high points and be released before the start of the Hydrostatic Test.

Field Hydrostatic Pressure Testing Procedure for uPVC / DI Pipe Lines

Hydrostatic pressure testing shall be carried out in accordance with AWWA C605-05 for uPVC pipelines and AWWA C600-05 for DI pipelines as per the following procedure.

Test Setup and Pressurization

The Contractor shall pressurise the pipe using a suitable pump connected to the pipeline at the selected Stop End and shall gradually increase the pressure to the specified test pressure. The pressure in the pipeline shall be seen to stabilize at the specified test pressure for at least 15 minutes before commencing the hydrostatic test, which may require several cycles of pressurizing and bleeding trapped air. The hydrostatic test shall be of at least a 2-hr duration. The test pressure shall not vary by more than + 34.5kPa for the duration of the test. Test pressure shall be maintained within this tolerance by adding makeup water through the pressure test pump into the pipeline. The amount of makeup water added shall be accurately measured in units of litres per hour by suitable methods approved by the Construction Supervision Consultant and shall not exceed the applicable testing allowance as specified below.

a) Testing allowance

Testing allowance shall be defined as the maximum permissible quantity of makeup water added into a pipeline undergoing hydrostatic pressure testing, or any valved section thereof, in order to maintain the specified test pressure after the pipeline has been filled with water and the air has been expelled. Pipe installation shall not be accepted if the quantity of makeup water is greater than that determined by the following formula.

In metric units,

$$Lm = \frac{SD\sqrt{P}}{794,797}$$

Where

Lm = testing allowance (quantity of makeup water), in litres per hour

S = length of pipe section being tested, in meters

D = nominal diameter of the pipe, in millimeters

P = average test pressure during the hydrostatic test, in kilopascals

When air valves and hydrants are in the test section, the test shall be carried out after removing those components and blank flanged at the branch off. After completing the testing air valves and hydrants shall be fixed with the sluice valve.

b) Examination

Any exposed pipes, fittings, valves, hydrants, and joints shall be examined carefully during the pressure test. In the event that the quantity of make-up water exceeds the permissible volume then any damaged or defective pipes, fittings, valves, hydrants, or joints that are discovered during or following the pressure test shall be repaired or replaced with reliable material, and the test shall be repeated until satisfactory results are obtained.

c) Acceptance of installation

The final acceptance test shall be carried out for the lengths passed the above tests and joined together on completion of construction for all the sections. Final pipeline acceptance test pressure shall be 4 bars and procedures shall be as described above.

Acceptance shall be determined on the basis of testing allowance only. If any test of a new pipeline discloses a testing allowance greater than that specified above, repairs or replacements shall be accomplished. All visible leaks shall be repaired regardless of the allowance used for testing.

Field Hydrostatic Pressure Testing Procedure for HDPE Pipe Lines

Hydrostatic pressure testing shall be carried out in accordance with "BS EN 805:2000 water supply- requirements for system and components outside buildings" for HDPE pipes using the following procedure.

The maximum hydrostatic test pressure shall be compensated for temperatures other than 73°F (23°C) as Polyethylene pipe materials are typically pressure rated at 73°F (23°C).

1) Test procedure

The whole test procedure shall comprise three phases: a preliminary phase including a relaxation period, integrated pressure drop test and main test phase.

- Preliminary Test Phase

- a) Relaxation period

Once the pipe has been filled and fully purged of air there shall be a relaxation period of at least 60 minutes during which the pipeline shall be submitted to normal atmospheric pressure in order to relieve any pressure related stresses. The pipe temperature shall not exceed 25°C during testing process.

- b) Pressure build-up

After this relaxation period the Contractor shall take no more than 10 minutes to increase the pressure smoothly and continuously to the specified test pressure using an appropriate pump.

- c) Pressure maintenance phase

The Contractor shall maintain the test pressure by continuously charging the pipe for a period of 30 minutes. Any obvious leaks (pipe joints, connection points) shall not be detected during this time.

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d) Expansion phase

Following the 30 min pressure maintenance phase the Contractor shall leave the pipe to expand and shall monitor the test pressure with no further pumping for 60 minutes, during which time the pipeline walls may stretch (expand) due to visco-elastic creep. If the pressure measured at the end of this period has decreased by more than 30% of the test pressure this indicates a leakage, or an excessive tube wall temperature ($>25^{\circ}\text{C}$) and the Contractor shall abandon the Hydrostatic Test, depressurize the test section, identify and remedy such anomalies before repeating the test from the beginning.

- Integrated Pressure Drop Test (vent control)

Following a successful 60-minute Expansion Phase the Contractor shall record the precise pressure and proceed immediately to rapidly reduce the test pressure to 85% to 90% of the specified test pressure by releasing a precisely measured volume of water from the pipe, V , and record the precise pressure in the pipe again to determine the instantaneous pressure loss p , which is used to calculate the maximum permissible water loss, $V_{\max}$, where:

$$V_{\max} = 1.2 \times V \times p \times [1 / E_w \times D / (e \times E_r)]$$

and:

$V_{\max}$ = the allowable water loss, in liters

V = volume of the tested pipeline section, in liters

p = measured pressure loss, in kilopascals

E_w = the bulk modulus of water, in kilopascals

D = internal pipe diameter, in meters

e = wall thickness of the pipe, in meters

E_r = circumferential modulus of elasticity of the pipe wall in kilopascals

1.2 = an allowance factor (e.g. for air content) during the main test phase

For the interpretation of the result it is important to use the exact value of E_r considering the temperature and the duration of the test. Especially it shall be for smaller diameters and shorter test sections. The values of p and V shall be measured as accurately as possible. If V exceeds $V_{\max}$ then the Contractor shall discontinue the test, depressurize the pipe and recharge it with water while venting any air that may have entered or remained in the pipe before repeating the test from the beginning.

- Main Test Phase

The visco-elastic creep due to the stress caused by test pressure is interrupted by the integrated pressure drop test. The rapid decrease of the pressure in drop test leads to a contraction of the pipeline, increasing the internal pressure. The Contractor shall measure the increase of pressure resulting from the Main Test Phase contraction at 1-minute intervals for a period of 30 min. The Main Test Phase shall be considered to be successful if the pressure curve shows a continuous increasing trend and does not

decrease at any time during this 30 minute period and the test section of pipe shall be considered accepted.

A decreasing pressure trend during that period may indicate the presence of a leak or seepage within the system. The Contractor shall then extend the Main Test Phase to 90 minutes and continue to measure and record the pressure at 1-minute intervals. The pipe under test shall be accepted in that case if the pressure loss over 90 minutes does not exceed 25kPa (0.25 bar) from the maximum value recorded during the contraction phase (the first 30 minutes of the Main Test Phase).

The Main Test Phase shall fail if the pressure drops by more than 25kPa (0.25 bar) over the 90 minutes. In that case before depressurizing the pipe completely the Contractor shall check all mechanical fittings before visually inspecting the welded joints. The Contractor shall rectify any defect in the installation revealed by the test and shall then repeat the entire test procedure from the beginning. The repetition of the main test phase shall be done by carrying out the whole test procedure from the Preliminary Test Phase.

L2-5.6.8.4 Disinfection

Before being placed into service, or before certification of completion by the Construction Supervision Consultant, whichever occurs earlier, all new pipelines which will convey treated drinking water shall be cleaned and checked to be free of dirt and foreign bodies and shall then be disinfected with chlorine. The amount and concentration of chlorine solution applied shall be such as to provide a dosage of not less than 50 mg per litre, introduced into the lines as directed by the Construction Supervision Consultant. Normally the point of application of the chlorination agent shall be at the beginning of the pipeline through a corporation stop insertion on the top of the laid pipe with the point of withdrawal (normally by blow-off) at the opposite end of the line.

After a contact period of 24 hours the Contractor shall take a water sample at the point of withdrawal at the end of pipeline for laboratory testing and submit the test result to the Construction Supervision Consultant for review. If the chlorine concentration in this sample is less than 25 mg per litre or greater then the Contractor shall drain the pipeline completely and repeat the disinfection process from the beginning. When the chlorine concentration of the sample is 25 mg per litre then the Contractor shall flushed the pipeline with clean potable water until the residual chlorine is not greater than 0.75 mg per litre but not less than 0.25 mg per litre and take a water sample at the point of withdrawal for bacteriological analysis of the in accordance with AWWA C601 and the certified result shall be submitted to the Construction Supervision Consultant.

If the sample meets the requirements of AWWA C601 the pipeline will be deemed ready to enter into service. If the sample fails to meet the standard required by AWWA C601 then the Contractor shall drain the pipeline and repeat the chlorination procedure from the beginning until a satisfactory result is obtained. The entire cost of the disinfection process shall be at the Contractor's expense and is deemed covered by the rates for constructing and commissioning the pipeline.

L2-5.6.8.5 Disposal of Water Used for Testing, Disinfection and Cleaning

Contractor shall provide suitable means for disposal of water used for testing, disinfection and flushing such that no damage results to facilities; to structures; natural water bodies, flora or fauna; or to property. These means shall be subject to the approval of the Construction Supervision Consultant and local Authorities. Details shall be submitted to the Construction Supervision Consultant upon request. The Contractor shall be responsible for

any damage caused by his filling, testing, disinfecting, flushing and disposal operations. The residual chlorine level of water for disposal operations to natural water bodies shall not exceed 0.1mg per litre.

L2-5.6.9 Pipeline Installation and Connections to Existing Water Mains

The Contractor shall consider schedule execution of such connections as early in the program as practicable, because the Employer will need to select a time when there will be least interference to the network and will not accept any requests for extensions of the Contractor period arising from delays in finding a suitable time for the connections.

The Contractor shall undertake a survey of all the underground existing utilities, obstructions and culvert foundations at the Sites and shall determine the exact locations and depths of all such underground utilities and obstructions. The results of the survey shall be incorporated in the "As-Built" Drawings.

Site Clearance and Excavations within the boundaries of the Sites for the Works shall only be carried out within the boundary of the Permanent Works. The Contractor shall engage a Geotechnical Expert who shall study the Ground Water condition, Existing Water-Logged Areas, Existing Water Table, Seepage of Water across the Excavation, Soil Layer Properties and Soil Types etc., to ensure the safety of existing structures and properties before or during Construction. The Geotechnical Expert shall consider all of the above studies and investigations and the safety of the existing structures and properties when preparing the method statement for both excavation and backfilling. The Contractor shall inform the Construction Supervision Consultant of all necessary precautions to be taken based on his own investigations and study. The proposed methods of excavation and backfilling shall be approved by the Construction Supervision Consultant prior to commencement of any such Works.

All the levels (Spot Levels and Contours) shall be recorded by a licensed surveyor prior to Commencement of the Site Clearing and Earthwork and these Levels and Contours shall be compared with the levels shown in the relevant Drawings and to be agreed with the Construction Supervision Consultant. In case of any discrepancy between the levels on the Drawings and the actual levels, the Contractor shall notify the Construction Supervision Consultant prior to commencement of any further Works.

Neither the Employer nor the Construction Supervision Consultant warrants the accuracy and completeness of the geotechnical and topographic information provided as part of this Document, and the Contractor shall be solely responsible for its interpretation and verification. Where the Contractor elects to interpret and use this data, it shall be entirely at his own risk and strictly subject to relevant clauses of the Condition of Contract.

The Contractor shall submit design calculations and details for supporting of trenches, including for shoring and bracing of trenches. The calculations and details shall be prepared by a certified geotechnical expert and submitted to the Construction Supervision Consultant for approval prior to carrying out any trench excavation for which the Construction Supervision Consultant requests such details considering the Site Condition.

For Pipeline structures such as Thrust Blocks and Valve Chambers, etc., excavation shall allow 800mm Working space for purposes of establishing Contractor's liability.

During backfilling, heavy compaction equipment shall not be used over HDPE Pipelines that have less than 300 mm cover of backfill material.

The Contractor shall complete the Pipe Laying, Backfilling and Compaction Works of excavated trench on the same day before leaving the Site. Open Pipe ends shall be covered and secured with temporary end caps to prevent the ingress of dirt, water, foreign bodies and

vermin at all times unless required to be exposed for the connection of another pipe or fitting and in any case at the end of every Working Day at all Sites and shall be maintained closed until the continuation of the Works.

Bridge, Culvert and Causeway Crossing Works shall be carried out concurrently with the Pipelaying Works, such that pressure testing, flushing and disinfection shall be carried out as a continuous system and the Contractor shall take this into account during the preparation of his Programmes for commencement of Pipe Works, Testing, etc.

L2-5.6.10 Service Connection Replacement and Installation

a) General

The Contractor shall prepare and submit two copies of method statements setting out in detail the proposed procedures for installing new service connections and replacing existing service connections to the Construction Supervision Consultant for comment and approval, including the criteria that shall be applied in deciding when not to use trenchless technology and standard design drawings for large and small meter installation. Work on service pipe replacement and installation shall not commence without the Construction Supervision Consultant's return of an approved copy of the final agreed versions to the Contractor.

Trenchless technology shall be available to be used wherever it can be employed and drilling of service pipe connections to new or existing water mains shall use the appropriate under-pressure drills and fittings. Where trenchless technology is infeasible then the Contractor shall prepare trenches for the service connections generally in accordance with this Specification pipeline trenching.

The Contractor shall backfill and reinstate all trenches and excavations associated with service connection installation and replacement in accordance with this Specification and shall systematically take and test samples of compacted backfill for compaction in the presence of the Construction Supervision Consultant. Trenches and excavations in which the backfill fails to meet the requirements of the Specification shall be re-excavated and backfilled with fresh material.

The Contractor shall follow the exact procedures recommended by the manufacturer and supplier of the under-pressure pipe equipment to install and secure the pipe saddles and to connect the corporation stops to them.

b) Service Connection Survey

The Contractor investigate every customer and meter in the area of Lot 2 listed in the CWASA billing system database on site to survey, record and photograph the location, orientation, size, type and serial number of each customer meter and associated service connection, identifying the location of the meter and stop tap, if any, to within $\pm 1.0\text{m}$ in plan, using latitude and longitude, UTM coordinates and Uber H3 level 15 identifiers. The survey shall also record any special features, such as sprinkler systems and other fire-fighting requirements, or connections to a tank or a pump that may increase or moderate the expected maximum flow rate. The Contractor shall submit the survey findings to the Construction Supervision Consultant.

c) Larger Diameter Customer Meters

When replacing or installing a new connection greater than 40mm ND, predominately for Industrial, Commercial and Institutional customers, the Contractor shall follow the meter manufacturer's recommendation for straight pipe

lengths upstream and downstream of the meter. Demand pattern of large customers to be investigated and requirements for combined water where required.. Also, if the future meter will be a mechanical meter, an upstream protective dirt box / strainer shall be installed.

d) **Small Diameter Customer Meters**

When replacing or installing a new connection 40mm ND and smaller, predominately for domestic and small business customers, The Contractor shall provide and fix a protective security cage to enclose the meter in an easily accessible location outside of private premises (design to be approved by the Construction Supervision Consultant and the Package CWSIP/G3 Contractor).

e) **Updating of records after installation and replacement**

Once the new or replacement service connection has been completed, tested and accepted by the Construction Supervision Consultant the Contractor shall complete the survey record of the connection with the details of the new connection, including photographs of the capping-off of the old connection to the distribution main, the new connection and the new meter location, with its precise coordinates and elevation.

Note: The new Customer Meters shall be installed by the Package CWSIP/G3 Contractor.

L2-5.6.11 Testing of Water Retaining Structures

The Contractor shall accept full responsibility for the watertightness of all water retaining structures and chambers. . The testing shall be conducted under the supervision of the Construction Supervision Consultant and all results shall comply with the criteria specified in BS EN 1992-3:2006 to ensure the integrity and water-tightness of the structure.

Repairs or patching to concrete shall not be carried out prior to the tests. Concrete shall not have porous or damaged areas patched over with mortar prior to the tests. If such Works are identified, then the tests shall be cancelled and all mortar patching removed so as to inspect the cast concrete.

All water retaining structures (Reservoirs, towers, tanks etc), excluding building superstructures, but including isolation valve chambers, washout boxes, air valve chambers, access and sewer manholes, etc. are to be considered as watertight structures and are to be tested as specified.

If any leaks or seepage identified more than the accepted amount, shall be repaired by methods as approved by the Construction Supervision Consultant. Approved methods shall involve chipping out of all porous areas, profiling of repair areas with squared off straight-cut voids, scabbling and roughening of areas to expose homogenous hard concrete surface, bond bridge adhesive application, and filling of voids with approved repair compounds.

L2-5.6.12 Indicator Plates and Marker Posts

Indicator Plates shall clearly identify Hydrants, Valve Types etc., as per the Standard Drawings, indicating the position of the item relative to the marker post.

Marker Posts and Indicator Plates shall be placed such that they are clearly visible from passing vehicles but do not cause obstruction to either vehicles or pedestrians, such as behind a footpath or in the boundary wall of the public thoroughfare nearest to the hydrant or Valve, etc. Labelling shall be in a font at least 10cm tall and printed against a reflective background to be readable at night.

L2-5.6.13 Repair and Replacement of Leaking Appurtenances

■ Sluice valves and hydrants

Leaking sluice valves and hydrants shall be replaced with new ones, even if only the stuffing box (gland) is leaking. Valves shall be installed complete with extension spindle, protecting tube and surface box or with hand wheel if the valve is located in a chamber. Hydrants shall be replaced at their existing location.

L2-5.6.14 Leak Repair

i. General

The Contractor shall notify the Construction Supervision Consultant of each and every leak repair and shall identify each one with a unique identifier composed according to rules agreed with and approved by the Construction Supervision Consultant. The details of each repair shall be recorded in a database against its unique identifier and the record shall include but not be limited to:

- a) A description of the location, including the standardised road name, address of nearest property and a short description
- b) The precise location of the repair to within $\pm 1.0\text{m}$ in plan, using latitude and longitude, UTM coordinates and Uber H3 level 15 identifiers
- c) If buried, the depth of the leaking pipe, joint or fitting below the undisturbed ground surface
- d) A description of the leaking item (e.g. water main, service connection, valve, rubber wrap repair, coupling, gland, PVC, cast iron, bronze, etc.) and the leak itself (e.g. hole, crack, gland, seal, O-ring, gasket, etc.), including diameter, material, appearance subjective flow category assessment (e.g. weeping, flood, spray, minor, average, large, etc.)
- e) The location and identifier of each valve or stop cock closed to isolate the leak from the supply, together with the times of closure before and re-opening after the repair
- f) A description of the repair, listing the materials used
- g) Digital images of the repair, each image to include a readable whiteboard showing the unique identifier of the leak and the following details of the repair process:
 - the undisturbed ground surface before the start of the repair work
 - the exposed leak, after excavation if that is required
 - a close-up of the leak
 - close-ups of the leak repair
 - the repaired leak in the excavation before backfilling
 - the restored ground surface after backfilling of the excavation
 - any items removed from the repair (e.g. damaged pipe, broken valve, failed coupling, etc.)

ii. Leaks on Service Connections

Leaking service connections shall be completely replaced from and including the tapping point up to and including the connection to the customer meter.

Wherever possible, the new pipe saddle shall be placed over the existing hole and a new drilling shall be avoided, otherwise the existing connecting point shall be sealed with a stainless-steel repair clamp and a new hole shall be drilled.

iii. Leaks on Main Pipes

Leaks on main pipelines shall be repaired by using stainless steel repair clamps. In case the damage is too large (e.g., longitudinal split) the damaged pipe shall be replaced by a section of new pipe, connected to the existing pipe with flexible joints or flange adaptors.

Intrusion of ground water into the main pipe shall be avoided as far as possible.

iv. Bedding and surround

Repairs to buried pipes and fittings shall be enclosed in a layer of compacted approved sand at least 100mm thick in all directions before placing and compacting backfill

v. Compaction and testing of backfill

Excavated material shall be removed for recycling and the excavation backfilled using approved hardcore that may consist of new or recycled material, free from sharp edges, organic matter and soft or degradable material. A sample of the compacted backfill shall be taken and tested compaction on site, witnessed by the Construction Supervision Consultant

vi. Temporary reinstatement

The surface layer of backfilling shall conform to the original surface or consist of approved temporary road resurfacing material pending final reinstatement as required by the roads authority or the Construction Supervision Consultant.

L2-5.6.15 Water Loss Reduction Works**i. General**

Among the expected benefits of the customer and network surveys, distribution pipe replacements and customer service connection and meter replacements is the elimination of accumulated historic background losses, unrepaired leaks and unmetered user connections. The DMA and Sector boundaries, meter chambers and monitoring points established by the Contractor and the bulk and customer meters, communication systems and control centres at Nasirabad and CWASA headquarters supplied and installed by the CWSIP/G3 Supplier are intended and expected to facilitate the rapid identification and elimination of any remaining concentrations of physical and commercial water losses in the distribution system and quickly signal the presence and approximate locations of newly emerging losses to facilitate their early elimination through the practice of Active Loss Control (ALC).

The Contractor shall expedite its establishment of DMAs and support the installation of meters and communication hardware by the CWSIP/G3 Supplier in order to initiate ALC activities in the DMAs to reduce NRW in the Contract Area to a level not exceeding 15% for the duration of the Maintenance Period. The Contractor's ALC activities shall include but not be limited to those described hereunder.

ii. Monitoring Water Loss Levels

The Contractor shall engage qualified and expert staff in sufficient numbers to monitor the flow, pressure and water quality data namely Temperature, Turbidity, Free chlorine, pH, EC and TOC from each DMA inflow metering point and critical monitoring point, using the displays, dashboards and software installed for that purpose by the CWSIP/G3 Contractor at the Nasirabad Control Centre and CWASA Head Office, who shall verify continuously the NRW levels in the Contract Area DMAs in order to select the DMAs

in which ALC activities are expected to achieve the greatest potential reduction in NRW at that time.

iii. Passive Loss Control (PaLC)

The Contractor shall establish and maintain a continuous communication link with the CWASA Call Centre to receive and act upon leaks reported to CWASA by staff, customers and members of the public. Each leak report shall be given its unique repair identifier by the Contractor's Work Order database. The Contractor's Loss Control Manager (LCM) and staff shall respond to each such report by:

- a) Locating it in the GIS to identify the corresponding DMA and Sector
- b) Immediately cross-checking the report against current flows and pressures in the corresponding DMA and Sector to see whether it corresponds to either a recent burst or its ongoing monitoring of water losses in that DMA and Sector.

If the report corresponds to a burst then the LCM shall immediately mobilise or redirect a Leak Repair Crew and Active Loss Control Crew to the reported leak location to precisely locate where the leak has occurred, coordinate with CWASA to identify and close off the section of the network in which the burst has occurred and repair the burst.

Otherwise the LCM shall check whether its ALC Crews have already reported a leak at or near to the reported location, in which case the two reports can be merged, or add it to the list of leak locations where the Contractor's ALC Crews will be directed to determine precise repair locations.

iv. Active Loss Control (ALC)

The Contractor shall engage, train, manage and provide foreign expert support for locally employed teams and nominated CWASA staff, and supply all necessary tools, vehicles, safety equipment, lighting, instruments and specialised pipe location, leak detection, noise logging, step testing and supplementary flow and pressure measurement equipment that they may require in order to locate leaks and unauthorised unmeasured water usage quickly, effectively and accurately in DMAs and on transmission pipelines within the Contract Area. The Contractor shall organise this staff into ALC Crews able to work mostly during the night to mark and record the Locations where the Contractor's repair crews shall be directed to repair suspected leaks and rectify unauthorised unmeasured water usage, the following day or as soon as permitted by the roads authority. A 24/7 supply shall be assured by the contractor during leak detection activities and plan operation of distribution pumps accordingly.

Each ALC Crew shall have a Crew Leader equipped with a mobile device linked to the CWASA GIS and the Contractor's Work Order database. The Contractor's LCM shall collate reported leaks from CWASA's Call Centre with leaks locations signalled by ALC Crew water loss surveys and the current DMA NRW estimates to prepare work schedules for water loss survey and precise leak location ALC Crews which shall be uploaded to each Crew Leader's mobile device.

The Contractor's mobile device software shall automatically generate the unique leak repair identifier for each suspected water loss location found during leak surveys or uploaded from Call Centre Reports. This identifier shall encode the ALC Crew name, the date of creation and a sequence number.

v. Periodic Reporting

The Contractor shall submit standardised Monthly Status Reports and Quarterly Progress Reports to the Construction Supervision Consultant. The content and format of

these Reports shall be agreed with and updated as instructed by the Construction Supervision Consultant.

Monthly Status Reports not exceeding four A4 pages in length shall be submitted within 3 working days after the last day of the reported Month and shall include but not be limited to:

- a) key statistics to date and for the current Month for the Contract Area as a whole, for each Sector in the Contract Area and for each DMA in each Sector, noting any differences between the DMA and Sector totals and the Contract Area and Sector totals, attributable to unmetered transmission pipelines, including key water balance parameters including breakdowns of inflow, consumption and NRW, number of Call Centre Reported leaks, number of ALC survey reported leaks, (that include Loses and unbilled authorized consumption) number of repairs carried out, number of dry holes, average number pending repairs, final number of pending repairs, average time to repair a reported leak and type of pipe and pipe materials used..
- b) key setbacks and successes arising in the Service Area during that month and expected issues in the next month.

Quarterly Progress Reports not exceeding ten A4 pages shall be submitted within one week after the last day of each Quarter and shall include but not be limited to:

- c) a summary of all works carried out during the quarter
- d) progress made during the quarter towards achieving the target level of NRW, including a quarterly water balance calculation for the Contract Area and for each Sector and historic trends to date
- e) a work program for the quarter ahead
- f) such other information as shall be required by the Construction Supervision Consultant.

vi. NRW Performance Report

The NRW Performance Report shall be submitted to the Construction Supervision Consultant no later than 30 Days after the final day of the Maintenance Period and shall include but not be limited to:

- g) final performance fee calculations, based on the final water balance calculation for the Contract Area for the 12 months of the Maintenance Period. audited and approved by the Construction Supervision Consultant. The water balance calculation has to follow the IWA Water Balance showing also imported and exported water as components.
- h) summary tables of all pipe and connection replacement, leak repair and customer meter installation;
- i) summary tables of number and types of leaks detected and repaired;
- j) updated GIS and a hard copy of the distribution network drawings of all DMAs;
- k) updated calibrated hydraulic model of the project area;
- l) as-built drawings for all main pipes installed and chambers constructed;
- m) table with target and intervention minimum night flow for all DMAs;
- n) DMA data management guidelines;



- o) pressure management guidelines that include maintenance recommendations and (if any) specific information for each PRV; and
 - p) descriptive summary of works carried out and problems encountered.
- vii. Commercial scope of work for each DMA**
- The Employer will provide the Contractor the customer database and billing history for the service area. The Contractor shall investigate the quality of the database and will ensure a good understanding of the database. The Contractor shall use the billing history of customers to identify any anomalies and discuss these with the Employer.
- viii. Establishment of Minimum Night Flow**
- Minimum night flow shall be calculated as the average of the lowest 60 consecutive minutes of unbroken night flow measurements taken on 7 consecutive nights in which minimum pressure at each DMA Critical Point exceeds 1.0 bar for 96% of the duration.
- ix. Sector and DMA Water Loss Measurement**
- Water Loss Measurement shall be carried out for minimum of 7 consecutive days in which minimum pressure at the DMA Critical Point exceeds 1bar for 96% of the duration.
- The consumption within the DMA (CQ) shall be calculated as the difference between their summation of customer meter readings at the beginning and end of the period. The smart meters and data collection system to be supplied and installed by the CWSIP/G3 Supplier are expected to facilitate the retrieval of the customer meter readings.
- The measured supply volume over the same 7-day period as CQ, IQ, shall be calculated as the net summation of the inflows and outflows at the Sector and DMA meter(s) over that same period.
- The Water Loss Level (WLQ) shall then be calculated as:
- $$WLQ = (IQ - CQ - UACQ) / 7 \text{ m}^3 / \text{day}$$
- where UAC stands for the Unbilled Authorized Consumption where applicable.

L2-5.7 Specification on M&E Works

L2-5.7.1 Double Suction Centrifugal Pumps

The pumps shall meet the following requirements,

Flange Class	PN16
NPSHA Capacity)	approx. +10 m (at 120% point of Rated Capacity)
Max. Noise level	85 dB (A) at 1.0 m
Driving method	Direct coupled
Installation	indoor
Motor encl. protection	IP 55
Materials - Impeller	Stainless steel casting SCS 13 JIS G 5121 or better
- Casing	Gray iron casting JIS G 5501 FC 200 / FC 250, or Spheroidal graphite iron casting JIS G5502

- FCD 450 or better
- Inner lining Applied for casing
- 1) Lining system;
Fusion bonded epoxy powdered coating,
epoxy resin coating or equivalent
 - 2) Application method;
 - a. Parts to be coated are to be heated in the furnace.
 - b. Epoxy powder is sprayed to the heated surface by compressed air system.
 - c. The powder is melted on the surface and thick / hard film is formed.
 - 3) Standard thickness of the coating;
minimum 400 microns
 - 4) Major application;
 - a. Pump inner coating system shall augment the strength of the metal surfaces by very thick and strong coating performance.
 - b. Friction loss inside pump casing shall be minimised for long term, preventing any build up foreign material on the coating surface.
- A. The pumps and their motors shall be installed on a steel fabricated common base plate. The pump and motor shafts shall be linked by a flexible gear coupling. The pump manufacturer shall have provided evidence off having furnished at least as many units of the same configuration and similar magnitude as the number to be supplied for this Contract.
- B. All shop tests shall be performed in accordance with the acceptance grade "1U" of "Pump test acceptance grades and corresponding tolerance" in the latest ISO 9906.
- C. The variable speed control is to provide a stable flow to the reservoir. Pump performance curves shall be identical as the pump is operating with variable speed drive.

L2-5.7.2 ICA Panel, Computer with SCADA software and Control Philosophy

L2-5.7.2.1 ICA Panel

Instrumentation panels shall incorporate the following components as a minimum,

- Sheet metal (2mm thick), powder coated panel enclosure meeting IP-54 with all equipment mounted
- Incoming power protection circuit breakers, surge arresters, control power distribution system
- Over current and surge protected power feeders for the field instruments
- Surge protected 4-20mA signal loops where the equipment is not loop powered



- 4-20mA signal isolators as necessary for relaying the 4-20mA signal to PLC etc
- PLC for equipment control and signal coordination with Central SCADA
- Fibre optic interface for connection where necessary.

Each Instrumentation Panel shall comply with the following requirements:

- Each panel shall be provided with self-regulating anti-condensation heaters.
- Surge arrester with surge discharge capacity of 10kA or more shall be provided for protecting all transmitters and all receiving instruments in the circuit from surge voltage induced in transmission lines and power supply lines due to lightning. Surge arrester shall be the plug-in type. Life monitor and surge counter function shall be provided.
- Space shall be provided to accommodate cable glands of appropriate size for incoming and outgoing circuits and non-ferrous gland plates shall be supplied. All glands' plates and trays shall be adequately earthed. Earthing of instruments and ICA panels shall be as per instrumentation / ICA manufacturer's requirements. If different earthing system is necessary transient couplers shall be provided with main earthing system.
- Terminals shall be clip-on or screw-on, DIN rail mounted, tunnel type terminals, with flat pressure plates.
- All field wiring and inter-panel wiring shall terminate at terminal strips. No more than one wire shall be connected to each side of a terminal. Bridging bars shall be used for paralleling wires.
- Terminals shall be grouped according to the working voltage of the circuits. Segregation shall be provided between low voltage and extra low voltage circuits by means of insulating barriers or by physical separation. Transparent insulating covers with warning labels shall be provided on 230V terminals. All terminal strips shall be safely accessible with the circuits in the service position and in normal operation.
- All terminals and terminal groups shall be identified with numbers in accordance with schematic and termination diagrams.
- All internal control wiring shall be single conductor, 1.5mm multi-strand flexible PVC insulated, copper wire.
- Both ends of every cable core shall be provided with approved marking ferrules. Identification shall be strictly in accordance with the wiring diagrams. Ferrules shall have black numbers on white or yellow background and shall fit firmly over the cable insulation. Ferrules shall be fitted so that on disconnection of cables from equipment the ferrules are retained on the cable.
- All main runs of wiring shall be enclosed in slotted PVC ducts. Duct sizing shall allow at least 30% spare space after all wires are installed. When not enclosed in ducts, wires shall be neatly and securely bunched and cleated. Form a loop in wiring runs which cross the hinge side of panels to prevent any strain being placed on the wires and terminations.
- The Contractor shall terminate all control wiring with pre-insulated crimp terminations of the correct size for the conductor and installed with the manufacturer's termination tool. The tool shall be of the ratchet type, which requires

- the correct pressure to be attained before the terminal can be released. Use pin type terminations for tunnel terminals and full circle tugs for stud or bolted terminals.
- Continuous copper earth bar shall run the length of each panel with terminals for connection to the main Grounding system. The cross-sectional area shall not be less than 3x25 sq.mm.
 - IO shall be provided for approval by Construction Supervision Consultant.
 - Minimum of two IO modules shall be provided in each type and parallel equipment shall be connected to each of them to minimize effect of single card failure.
 - A service contract for a period of 2 years after the defect notification period shall be proposed with the bidding document. Upon completion of the project the main contractor is no longer responsible for ICM system. The agreement shall be renewed according to the given guidelines of the bidding document and shall be submitted proposal with the ICM contractor.
 - RS 485 module or suitable serial communication devices shall be provided to communicate between the VFDs and the high voltage panels at the ICA panels, power analysers, diesel generators etc.
 - Communication of ICA with other facilities which are not within the same building shall be with optical links.
 - Contractor shall supply all necessary software with license for a minimum period of 5-years.
 - All equipment supplied shall have after sales support and bidder shall provide documentary evidence to this effect at the time of bidding.
 - All information available in the SCADA and ICA shall be made available through internet for secure access by authorised computer or smart device. Software for such operation shall be included.
 - Additional fibre optic port shall be provided for communication with future equipment.

L2-5.7.2.2 Computer with SCADA software

- SCADA system including Computer with SCADA software shall be provided for each ICA so that the operator can access the PLC for implementing necessary operational changes, and for the Construction Supervision Consultant to implement necessary changes to the controls.
- Computer shall be server grade from a reputed manufacturer.
- Cost of all network components and installation shall be included.
- All software shall be included and software with license shall be installed
- Configuration of the computer system shall be as per the latest available at the time of implementation.

L2-5.7.2.3 Control Philosophy for Transmission and Distribution Pumps

Control Philosophy and additional requirements applicable for main pumps (Direct Distribution Pumps and Transmission Pumps) shall be as specified below,

Control of the main pumps shall be possible at four locations as indicated below,

LOCATION	EXTENT OF CONTROL	REMARKS
Close to the pump with Local Operation Station (LOS)	Start and stop control with emergency stop – No speed control	Only for maintenance
At the VFD	Full control including speed	
At MCC	Full control including speed, control of the delivery MOV shall be also possible	Note-1
At SCADA	Full control including pump start / stop from SCADA shall be available under manual from SCADA. Under auto from SCADA several modes shall be available. These modes shall be different for Transmission and Distribution Pumps.	Applicable modes relevant to Transmission pumps and Distribution pumps under auto from SCADA are specified at the end of this section.

Note-1**Further notes on control mechanisms**

- **Interlocking-1** – Using the pressure transmitter and flow meter readings PLC shall perform pumping system check and when excessive deviations from the typical system, (especially sudden change) is detected, alarm condition shall be generated.
- **Interlocking- 2** When remote reservoir is fed from the bottom and when the remote reservoir level is low there is a risk that insufficient head forces the pump into the runout condition. This situation shall be detected by pump current (from VFD) and pump vibration level (from vibration transmitter). Either condition shall generate an alarm to alert the operator. PLC shall be programmed to control the situation either by reducing the speed of the pump or by stopping the pump altogether. The procedure shall be finalized at the time of commissioning with the participation of pump manufacturer's representative.
- **Hardware interlocks-** Hardware interlocks such as dry run protection shall be implemented in the MCC and shall function even during ICA panel failures.
- **Pump starts and stops** shall be gradual under PLC control to minimise hydraulic surges in the line.
- **Load sharing:** While all pumps shall operate at the same frequency and all pumps shall share the load equally under normal conditions, provision shall be made in the control to use the kW loading information from the VFD to make small individual pump speed adjustments to ensure equal load sharing.
- **Note on Hardware requirements:** The Contractor shall submit the details of the system design, hardware, software and programming for implementing the specified control system and philosophy to the Construction Supervision Consultant for approval before purchasing the necessary hardware and software. If the Contractor's pump controls do not fully comply with the requirements of this Specification during Commissioning Tests

and Maintenance Period operation then the Contractor shall submit a proposal for remedial hardware and software upgrades to the Construction Supervision Engineer for approval before purchasing and installing them entirely at his own expense.

- **Note on duty sharing-** the Contractor shall ensure and demonstrate that duties are distributed equally between parallel equipment.
- **Time delays, ramp times etc.** shall be adjusted after installation by the Contractor to suit site conditions during testing. The Contractor shall be responsible for establishing a smoothly operating control system with no hunting or excessive deviations from the set values.
- **Note on alarms** – the Contractor shall ensure that in any and all situations which require operator intervention or awareness the MCC, ICA and SCADA shall trigger the generation of corresponding alarm condition at the applicable level. Critical alarm conditions within each structure shall also be signalled by a wall mounted siren and beacon light.
- **Notes on protective interlocks** – The Contractor shall include Protective Interlocks as recommended by the Equipment Manufacturer as prerequisites for operation of each equipment.
- **Notes on PLC Interlock operation** - The Contractor shall provide all starters in the MCCs with PLC interlock such that the PLC can inhibit operation of any equipment from MCC or LOS to prevent unsafe operation of equipment as decided by the SCADA (e.g. operation of the third pump in a pumping system where only two pumps are on duty) and shall also make provision in the SCADA to release this interlock for a specific period of time for maintenance etc.
- **Notes on parameter settings** - Individual parameter settings shall be programmable for each equipment and system from ICA or SCADA computer interface and any remote panel or computer with access protected by login with password.
- **Note on power failure handling** – control equipment shall be protected from a mains power supply interruption with appropriately sized uninterruptable power supplies and programmed to restart the facilities they control after resumption of power to resume their previous operating status. If there are specific additional requirements they shall be indicated for each equipment or system.
- **Notes on communication failure** - each PLC shall be programmed to detect and continue to perform its control functions for the directly associated equipment independently during a network failure. Operator shall be alerted for any additional information necessary which would be normally obtained through the network.
- **Default program** – In each PLC a default program shall be provided for handling emergency situations such as communication failures or serious alarm conditions.
- **Operation under generator power** - Each PLC shall include an Operator-selectable stand-by power supply operating regime to control the pumps and other electro-mechanical plant to keep the maximum instantaneous load within the acceptable range of the stand-by generator. If necessary the Operator shall be prompted to enter a new set of parameters for pump operation under generator supply to ensure generator is not overloaded, such as the priority of the pumps.
- **Note on measurement validation** - All flow measurements shall be validated with real time consistency checks with associated measurements so that erroneous measurements can be identified immediately (e.g. inlet flow to the sump, sump water level and pump delivery flow are interlinked and therefore each measurement can be validated with other two measurements). In the event of a persistent validation failure the Operator shall be prompted to instigate further investigation by an alarm. Parameters for validation shall be agreed with the Construction Supervision Consultant at the time of commissioning.

- **Note on future equipment** - All equipment planned for future installation shall be included such that all the corresponding signals and programming shall be completed in ICA, SCADA and PLC to the point where only connection termination to the ICA panel terminal board shall be required for its control. Planned future equipment shall show in the ICA and SCADA screens as defective or unavailable equipment. The Contractor shall use simulations to demonstrate proper operation of the inputs and outputs when the time comes to commission the future equipment.
- **Access to SCADA system** – user access to the SCADA system shall be controlled by login levels and passwords to provide appropriate access for monitoring and downloading content while restricting control and parameter adjustments to only specifically authorised and qualified users.
- **Note on programming:** Extensive site programming will be necessary to modify or change programming of the PLC, HMI and SCADA to meet control and operation requirements of the selected equipment for easy and efficient operation of the plant so the Contractor shall anticipate and allow for any and all expenses associated with this requirement in his prices.
- **Note on the discharge MOV, pump starting and stopping:** The discharge MOV shall be closed while the pump is not operating and before starting the pump. The PLC shall send the opening command to the discharge MOV when starting the pump. Single pump starts and stops with no parallel pump, typically applicable only after power failure and complete shutdown of the pumping system, shall be gradual and under PLC control. Pump starts with parallel operation shall be under PLC control to increase speed gradually to allow sufficient time to also slow down the speed(s) of the parallel pump(s) to prevent abrupt changes in overall output pressure and flow. Conversely, when stopping the pump, the PLC shall gradually reduce the speed to allow it sufficient time to increase the speed(s) of the parallel pump(s) to prevent abrupt changes in overall output pressure and flow and send a closing command to the pump discharge MOV. When there is no associated speed signal increase for the parallel pump, the pump shall be stopped at ramp down rate and the discharge MOV closed.

For direct distribution pumps, the SCADA shall provide following automatic operation modes:

- a) **Mode-1** Constant delivery pressure
- b) **Mode-2** Time based delivery pressure
- c) **Mode-3** Friction compensated delivery pressure
- d) **Mode-4** Control mode with critical point pressure measurement

The SCADA shall control the number of pumps in operation and the pump speeds under each of the above options as indicated below:

- Start with one pump and speed up until the required pressure is reached.
- If the flow exceeds the maximum allowed for the pump before reaching the required pressure, the second pump shall be started
- Both pumps shall operate at the same speed which shall be adjusted to maintain the required pressure.
- If the total flow exceeds the maximum flow allowed for two pumps, then the third duty pump, if available, shall be started and operated as previously described.
- If the required pressure cannot be achieved with all duty pumps operating at maximum speed, then an alarm condition shall be initiated and all pumps shall operate to maintain the highest possible pressure.



- When the water demand drops and the minimum operating speed for the pumps is reached, one pump shall be stopped while the remaining pump(s) speed up to maintain the required pressure.

For transmission pumps when pumping to single reservoir - VFD Pumps: the following modes shall be provided when operating under auto mode from SCADA or ICA

- a) **Mode-1 – Fixed flow** - the required flow rate shall be entered manually and the PLC shall maintain the required flow by starting and stopping pumps and adjusting the VFD frequency
- b) **Mode-2 – Fixed pressure** – the required delivery pressure shall be entered manually and the PLC shall maintain the required delivery pressure by starting and stopping pumps and adjusting the VFD frequency
- c) **Mode-3 – Schedule** - the required flow rates are entered into the weekly schedule manually and the PLC shall maintain the required flow in each time slot according to the schedule by starting and stopping pumps and adjusting the VFD frequency
- d) **Mode-4 – Remote reservoir level** - the required remote reservoir water levels shall be entered into the weekly schedule manually and the PLC shall calculate the required flow rate based on the remote reservoir water level and use that rate dynamically to control the pumps. Special control shall be included to handle exceptional situations such as recovery after long duration power interruptions resulting in emptying of the reservoir.

Under each of above options the number of pumps in operation and the speed of pump operation shall be controlled as indicated below:

- Operation shall start with one pump and shall increase pump speed until the required flow and pressure are reached.
- If the flow exceeds the maximum allowed for the pump before reaching the required pressure and flow the second pump shall be started
- Both pumps shall operate at the same speed which shall be adjusted to maintain the required pressure and flow.
- If the total flow exceeds the maximum flow allowed for two pumps, then the third duty pump, if available, shall be started and all three pumps operated as described above.
- If the required pressure and flow cannot be achieved with all duty pumps operating at maximum speed then an alarm condition shall be initiated and the pumps shall operate to maintain the highest possible flow.
- When the water demand drops and the minimum operating speed for the pumps is reached, one pump shall be stopped and the speed of the remaining pumps increased to reach the required pressure and flow

Notes:

- Under all operating modes, the remote reservoir level signal shall be obtained through local panel at the remote reservoir. When the reservoir water level reaches 5cm below the overflow level an alarm condition shall be generated for operator interaction and the pump flow and pressure shall be reduced to maintain this level.
- If the water level at the remote reservoir reaches overflow level, due to signal failure or other equipment failure, then the reservoir inlet MOV shall be gradually closed. When this situation shall be detected at the pump station as increasing delivery pressure and reducing flow this shall initiate an alarm condition and shall prompt complete shutdown of the pumps.



- If all pumps stop for any reason, they shall only restart either when the remote water level drops to a pre-set value or after a pre-set delay time if the reservoir level signal is interrupted.
- Based on the required flow rate pumps are operated as indicated below:

REQUIREMENTS FOR THE TRANSMISSION AND DISTRIBUTION PUMP MOTORS

Following requirements are to be met

1	Minimum efficiency	96%
2	Insulation class	F
3	Converter operation	Required for VFD driven motors
4	Bearing insulation	Both NDE and, DE required for VFD driven motors
5	Shaft grounding	Required for VFD driven motors
6	High humidity winding	Required
7	Fan design	To suit low speed operation required for VFD driven motors
8	System efficiency class -as per IEC-50598	IES-2 class shall be ensured for the drive and motor combination
9	Maximum temp rise- with converter operation at full load under worst supply conditions	B
10	Bearing lubrication	With grease nipple
11	Winding 3 X PT-1000	Required
12	Motor bearing 2 X PT-1000	Required
13	Pump bearing 2 X PT-1000	Required
14	Pump vibration transmitter	Required for distribution pumps
15	Heater	Required

REQUIREMENTS FOR THE DRAIN PUMP ETC. AND SIMILAR SUBMERSIBLE MOTORS

Following shall be provided

1	Overheat protection	Thermistor / built in thermostat
2	Water leakage protection	Required

REQUIREMENTS FOR ALL OTHER MOTORS RATED 5.5KW OR MORE

Following shall be provided

1	Overheat protection	Thermistor
2	ACH- using heater or using motor winding	Required
3	IP rating	54 in dry area 65 in damp area

L2-5.7.3 Induction Motors

- | | |
|---------------------|--------------------------------|
| a) Type | : Totally enclosed, fan cooled |
| b) Standard | : IEC-60034 |
| c) Insulation class | : F |
| d) Temperature rise | : That of Class B |

Notes on motor selection:

- Motor capacities and similar requirements for the motors are indicated under mechanical specification for equipment. (Note: Motor capacities indicated are minimum values, actual capacity shall be decided by the motor manufacturer considering selected pump and selected drive ensuring temperature rise and other requirements under worst conditions. Contractor shall ensure associated components such as cables, drives, contactors, breakers are changed accordingly)
- All motors shall be rated for operation at 400V+/- 6%. When the motors are VFD operated, voltage drop due to the VFD may lead to a situation where the motor cannot be fully loaded under the worst supply conditions. In such case motors with extended low voltage range or motors with a higher capacity margin shall be used. Alternatively, pumps with rated capacity at less than 50Hz may be proposed to the Construction Supervision Consultant at the time of equipment selection.

Additional electrical requirements for motors are indicated below.

L2-5.7.4 Lifting Equipment

All lifting equipment shall have the minimum specified rated capacity or be capable of lifting 25 percent more than the weight of the largest piece of equipment or pipework within its reach, whichever is the greater.

Electrically operated cranes shall have two lifting speeds: normal lift shall operate at 1.8 m/minute and creep control lift shall operate at 0.2 m / minute. Cross travel shall be at 10 m/minute and long travel shall be at 15 m / minute.

Cranes shall be provided with platforms & ladders for safe access to crane components for maintenance.

Power cable arrangement

- | | | |
|---------------------------|---|-----------------------------------|
| • For crane long travel | - | Insulated Busbar |
| • For crane- cross travel | — | Zig-sag cable |
| • For monorail | — | Insulated Busbar or Zig-zag cable |

The cranes and hoists shall meet the operational and dimensional requirements as follows:

Purpose	to lift equipment - up, down traversing and travelling
Type	Electrically operated Overhead Single Girder Wire-Rope Crane
Rated capacity -	1.25time maximum load.
Motor encl. protect	IP 55
Installation	Indoor
Materials	Gear; Carbon steel
	Shaft; Carbon steel
	Drum; Rolled steel

Accessories (per unit) Cap tire cable, Controller, Cable hanger, Power box, Pull box etc. necessary for completion.

L2-5.7.5 Power Transformer (Oil immersed type)

Type	Oil immersed hermetically sealed, naturally cooled, double wound, core type, indoor installation
Standard	IEC-60076
Rated voltage	33 (or 11) kV / 0.4 kV
Rated frequency	50 Hz
Rated percent impedance	5.5 percent
Protection	temperature (85 °C alarm and 90 °C trip), over current relay, ratio differential relay, grounding over-current relay, Buchholz relay, Oil level Failure status on the transformer shall be monitored and logged in PLC and SCADA.

Method of connection

HV winding	Delta connection
LV winding	Star connection, neutral solidly earthed
HV winding	
Vector group symbols	Dyn 11
Permissible winding	
Temperature (Measured by resistance method)	55-degree C
Bushing type current transformer	CT Ratio (LV side) Full load A / 5A
HV termination	Plug-in type
LV Termination	Busbar with cable box
Handling	Lifting hooks, from side and from top
Mounting	With wheels, on rail
Product approvals:	Type tests certificates issued by internationally accepted testing agency.

L2-5.7.6 Power Transformer (Dry type)

Standards	: IEC-60076
Type	: With enclosure suitable for indoor installations
Protections	: Built-in protections
Product approvals	: Type tests certificates issued by internationally accepted testing agency.

L2-5.7.7 Motor Control Centres (MCC)

MCC shall meet the following requirements,

- Standard – IEC 439
- MCC shall be protected to IP 54 and be subject to form 3b.
- Rated voltage - AC 600 V
- **Additional features** - Internal light with door switch for each cubicle.
400 / 230V isolation transformer with MCB for control power in each cubicle.
- **Breakers**- all MCCB and ACBs shall be adjustable thermal trip. Above 250 A a magnetic switch also shall be adjustable. Trip unit shall be field replaceable.
- All ACBs and MCCB shall be with communication and connected to ICA.
- Surge diverters shall be connected to ICA for remote monitoring.
- **Equipment protections at MCC level**- Pump protection against low suction water level, low suction pressure, over pressure on delivery, over temperature etc. are to be included in the MCC. (Common control cubicle shall be provided in each MCC for coordination of these protections)

L2-5.7.8 Standalone VFD for Main Pumps

Independent VFD motor starter panels shall be provided for main pump motors.

Following requirements shall be met,

- **Harmonics** - Low harmonic drive with less than 5% TDH(i)
- **System efficiency class** - as per IEC-50598 IES-2 class shall be ensured for the drive and motor combination
- **Efficiency**- better than 96%.
- **In-built main components** - Main power switch, Fuses, DC choke, dv / dt filter.
- Power module bypass for partial loading when one power module is defective.
- Touch screen for control, monitoring and parameter settings.
- IP-54 enclosure
- Serial Communication port for connection to PLC.
- Discrete signals for ON / OFF / REMOTE / FAULT and RUN command with Local remote selector
- **Motor winding, motor bearing and pump bearing temperature, vibration monitoring**-It is acceptable if VFD can be customized to include motor / pump monitoring. However critical status shall indicate MCC and all information shall be available in SCADA.

L2-5.7.9 Local Control Panels (LCP), Local Operation Stations (LOS) and other dedicated control panels

As indicated in the scope of work.

L2-5.7.10 Energy Efficiency Monitoring and ControlGeneral

Energy monitoring and other energy related measurements and reports shall be prepared for each SCADA system individually.

Instantaneous energy data, along with equipment status shall be presented in the HMI of the ICA panel and SCADA computer.

Additionally, the historical data shall be available from the SCADA computer in standard formats. On demand reports shall also be available in formats as per operator requirements.

All reports shall be accessible from any other computer or smart device connected to the system.

Energy Cost Reduction

The following measures shall be implemented to minimise the energy costs with or without operator intervention. If the operator intervention option is selected, operator alerts shall be issued at the appropriate time.

- Possibility of using off-peak power to the maximum extent.
- Scheduling of pumping to minimize kVA demand
- Reducing pumping rates with transmission pumps to minimise friction losses

Performance Tests (For Typical Pump)

Performance tests shall be carried out for transmission and distribution pumps during normal operation wherever possible. If special requirements are necessary an operator alert shall be generated so that operator can arrange for necessary background. (For example, pump performances can be monitored when only one pump is running in the system and if this situation does not occur for a long period of time, operator may artificially induce the situation to carry out the performance test). Performance reports shall be presented in a similar format to that indicated below,

PUMP PERFORMANCE REPORT		DATE:
Pump tag NO.		
Pump flow (M3 / Hr)		
Pump delivery pressure (M)		
Suction residual head(M)		
Total head generated by pump (M)		
Hydraulic power (kW)		
Frequency of supply (Hz)		
Power absorbed by pump (kW)		
kW Absorbed by pump (kW)		
Estimated pump efficiency		
Highest efficiency recorded at the speed		
Average efficiency recorded at the speed		

Pump performance records shall be retrievable as historical data.

Distribution pump- Pressure incremental cost

Pressure incremental cost (Percentage increase of energy for increasing delivery pressure by one meter) against flow shall be presented as a curve for each distribution pumping system.

4

Energy Reports

Energy data shall be monitored at different levels and all necessary information shall be presented as daily, weekly and monthly energy reports. Formats indicated below may be considered as preliminary. Final formats for the reports shall be designed by the contractor in consultation with Construction Supervision Consultant.

Monthly Energy Report

For each location:

MONTHLY ENERGY REPORT BASED ON SCADA MEASUREMENTS			YEAR	MONTH
DETAIL	TOTAL	PEAK	DAY	OFF PEAK
	(FROM SCADA)			
Total energy (1000 kWhr)				
Maximum demand (kVA)				
Date / time of maximum demand for plant				
Specific energy (kWhr / M3)				

Auxiliary power cost

Total energy for auxiliary power				
----------------------------------	--	--	--	--

Reconciliation of electricity bill

From Bill	TOTAL	PEAK	DAY	OFF PEAK
		18.30 – 22.30	5.30 – 18.30	22.30 – 05.30
Energy				
Total energy (1000 kWhr)- From SCADA				
Total energy as per bill (Enter manually) – (Alert operator to input data)				
Discrepancy (kWhr)				
KVA Charge				
Max. kVA from SCADA				
Max. kVA from CEB bill				
Discrepancy				

OPTIMISATION OF MAXIMUM KVA

Maximum kVA Demand for each main pump and for the station shall be presented as a monthly chart so that the operator can optimize pump operation to reduce maximum demand cost.

L2-5.7.11 Local Control Panels (LCP), Local Operation Stations (LOS) and other dedicated control panels

Explanation of terminology

LOCAL CONTROL PANEL (LCP)	Local Control Panels (LCP) normally supplied by the equipment supplier for packaged type equipment. All control functions applicable for the package type equipment are implemented within the LCP which normally require power supply and control cable connection to SCADA system for monitoring and control as applicable for the package.
LOCAL OPERATION STATION	Local Operation Station (LOS) is a simple push button station typically installed close to the associated equipment for operating the equipment under repair and maintenance.
DEDICATED CONTROL PANELS	Dedicated Control Panels are similar to LCP but not associated with any packaged type equipment. They are normally used for a group of equipment.

Local Control Panels (LCP) for Chlorination

- A. Local Control Panels shall be provided for chlorination plant and neutralization plant.
- B. Following requirements are to be met in general:
 - Local Control Panel shall be supplied by the package equipment manufacturer as part of the package.
 - All control functions relevant to the associated equipment shall be implemented within the local control panel only requiring external power supply.
 - Control and monitoring interface for connection to PLC shall be provided.
 - Two Nos. 400 / 230V Isolation transformers each rated at 50% loading for control power shall be provided in each LCP
 - Further details applicable for local control panels are indicated under relevant mechanical specifications.
 - Specific requirements for Local Control Panels are indicated in the following tables.

Chlorination Control LCP			
	Quantity	1	
	Mounting	as per manufacturer's standard	
	Enclosure	IP-65, powder coated	
	Equipment protections / monitoring	As per manufacturer's standard	
	Instrumentation	As per manufacturer's standard, with	

		motive water pressure switch	
	Chlorination modes	Multiple control modes including flow proportional mode, and cascade control of residual control with flow control.	
	Control interface	Status signals for main PLC.in ICA panel	
	Functionality requirements	- Fully Manual Operation and operation with electrical push buttons need to be available from LCP / Package control panel with the selection of manual operation from LCP / Package control panel. - When "Remote" mode selects from LCP, Manual Operation and auto operation with reference to the preset dosing rate and incoming flow rate need to be available from ICA. - When "Remote" mode selects from ICA, the manual operation and fully auto operation with reference to the pre-set dosing rate and incoming flow rate need to be available in SCADA.	
Chlorine neutralization plant LCP			
	Quantity	1 No	
	Mounting	as per manufacturer's standard	
	Enclosure	IP-65, powder coated	
	Equipment protections / monitoring	Chemical tank low level protection and alarm	
	Instrumentation	As per manufacturer's standard	
	Operation modes	Auto based on chlorine gas detectors.	
	Control interface	Status signals for main PLC.in ICA panel	

Local operation station (LOS)

C. List of LOS is indicated in the following drawing Nos.

- e) KGWSEP (1) / PK3 / 50 / KEL / G / E-006
- f) KGWSEP (1) / PK3 / 40 / KES / G / E-006
- g) KGWSEP (1) / PK3 / 65 / MOR / G / E-006
- h) KGWSEP (1) / PK3 / 35 / BAN / G / E-006
- i)

- D. Refer to standard electrical drawing for arrangement guidelines. Contractor may propose standard LOS panels from reputed manufacturers. Samples shall be supplied for approval before fabrication.
- E. Local operation stations shall be provided adjacent to equipment concerned, to control the equipment manually, for maintenance or under emergency situations.
- F. Following shall be provided in the local operation station,
 - **Emergency stop.**
 - ON push button
 - OFF push button.
 - Running indicator
 - Stop indicator
 - Fault indicator
 - Selector switch LOCAL-OFF-REMOTE
 - **Especially for submersible equipment-** Set of terminals for termination of submersible cables with field cables.
- G. Enclosure protection - as indicated in schedules

L2-5.7.12 Heavy Duty 3.3kV Reserve Diesel Generator Station

Heavy Duty 3.3kV reserve Diesel Generator Station shall provide power for Pumping Stations and Water Treatment Plants in the event that the 3.3kV grid supply is interrupted. It shall comprise:

- The Standby Generator Building / Enclosure, ventilated to provide cooling air for the engines.
- One duty and one standby diesel generator with integrated cooling for the engines and generators, ducted air intakes and silenced exhaust pipes to the outside of the building, each protected from the ingress of animals, insects and rainfall and surrounded with ample space for routine maintenance, servicing and repairs.
- Double skinned shaded fuel tanks adjacent to the building with sufficient capacity to provide 10 days of continuous operation at full load, with paved hardstand for refuelling trucks, all surrounded by spillage containment barriers and drainage equipped with high-capacity oil traps.
- Secure HT switchgear enclosure adjacent to the Generator Building to receive the incoming HT grid supply, the output of the diesel generators and the supply to the pumping station or treatment plant.
- Glazed soundproof and fireproof air-conditioned control room overlooking the generators to house all instrument displays, controls and LT relays and switchgear, with office space, showers and toilets for the operators and secure doors to the exterior of the building and to the generator room.
- Controls to provide the following modes of operation:
 - Manual disconnection from the grid supply and start-up of the duty generator by the operator following an interruption to the incoming grid supply, followed by a manual shut down of the generator and reconnection of the supply to the grid supply once this has been restored.



- Manual transfer of the power supply from the duty generator to the standby generator during prolonged operation by disconnecting the duty generator from the supply and connecting the standby generator in its place.
- Automatic disconnection from the grid supply and start-up of the duty diesel generator once a loss of grid supply exceeding 10 seconds duration has been detected, followed by automatic disconnection of the HT load from the duty generator and subsequent reconnection to the grid supply following a 2-minute resumption of the grid supply, followed by shut-down of the duty generator.
- Automatic transfer of the power supply from the duty generator to the standby generator triggered by the operator during prolonged operation by disconnecting the duty generator from the supply and connecting the standby generator in its place.
- Automatic transfer of the power supply from the duty generator to the standby generator without interruption to the supply by starting the standby generator and using a synchronisation unit to match the standby generator phase sequence, voltage magnitude, frequency and phase angle to those of the duty generator before a handover period of synchronous operation, followed by disconnection and shut down of the duty generator.
- Pre-emptive operator triggered automated transfer of the power supply from the grid supply to the duty generator without interruption to the supply by starting the duty generator and using a synchronisation unit to match the duty generator phase sequence, voltage magnitude, frequency and phase angle to those of the grid supply before a handover period of synchronous operation of the grid supply and duty generator together, followed by disconnection of the grid supply before a notified interruption of the grid supply.
- Operator triggered automated transfer of the power supply from the duty generator to the grid supply following a resumption of the grid supply without interruption to the supply by using a synchronisation unit to match the duty generator phase sequence, voltage magnitude, frequency and phase angle to those of the grid supply before a handover period of synchronous operation of the grid supply and duty generator together, followed by disconnection and shut down of the duty generator.
- Fully automatic transfer of the power supply from the duty generator to the grid supply following a detected resumption of the grid supply without interruption to the supply by using a synchronisation unit to match the duty generator phase sequence, voltage magnitude, frequency and phase angle to those of the grid supply before a handover period of synchronous operation of the grid supply and duty generator together, followed by disconnection and shut down of the duty generator.

L2-5.7.12.1 Electrical specification for high voltage switchgear

a. Standards

The switchboard cubicles shall be manufactured and tested in accordance with IEC 60298/ BS EN IEC 62271

Type Test Certificate for the type of switchgear offered shall be submitted.

b. Construction

Modular type.

c. Quality Assurance

High Voltage switchgear shall be manufactured by a reputable multinational company with strict internal functionality and quality control. All necessary details of the manufacturer shall be submitted for approval. All products shall be manufactured in a facility with ISO-9000 certification.

d. Documents to be submitted

The Contractor shall submit complete fabrication drawing with lists of material and catalogues and all other information for approval.

e. Ratings

The ratings of the switchgear shall be selected according to the selected duty. Excess capacity of 10% shall be provided. Necessary calculations shall be submitted for approval.

f. Busbars

The busbar system shall be copper with epoxy coating.

g. Circuit Breakers

The circuit breakers shall be maintenance-free sealed-for-life, vacuum horizontal draw-out, motorized, truck-mounted type complying with IEC BS EN 62271. The circuit breakers shall be motor-charged spring stored-energy mechanisms, with panel mounted push buttons.

i. Interlocks

Electro mechanical interlocks shall be provided for preventing unsafe operation of breaker, truck and earth switch etc. Mechanical interlocking shall be used within the feeder cubicles to prevent faulty operation of circuit breakers, switch trucks and earthing switches.

ii. Surge Arresters

Surge arrestors shall be provided for diverting surge voltages to the ground without causing any damage to the equipment.

iii. Operation

Operation of the breakers shall be possible from panel mounted push buttons and remotely by SCADA. Communication port shall be available in the LV control cubicle for communication with SCADA.

h. Protection Relays

Multifunction programmable protection relays shall be used for the protection including downstream protection for transformer. The following minimum shall be provided in each incoming and outgoing feeders:

- 3-phase overcurrent protection (time and instantaneous)
- Ground overcurrent (time and instantaneous)
- Phase unbalance and reversal
- Transformer protection for TR feeders (Differential, over temp. etc).

i. Details of the protection relays shall be submitted for approval. (MICOM-P127 or equivalent) Fault currents

Switchgear shall be rated for maximum fault current available at site. Minimum shall be 31.5kA for 3 seconds.

j. DC Supply

DC Supply shall be 110V. 110V DC supply unit shall be included.

k. Indicators

Power analyzer shall be provided for monitoring of each cubicle. Power analyzer shall be connected to PLC with communication.

l. Anti-Condensation Heaters

Anticondensation heaters with thermostat shall be provided in each cubicle.

m. Transformers

Current transformers (protection and metering), potential transformers shall be provided in each cubicle.

n. Test Terminal Blocks

Test terminal block shall be provided in each cubicle for current and voltage.

o. Spare parts

Spare parts recommended for 5-year maintenance by manufacturer shall be included.

L2-5.7.12.2 Diesel generator units

Diesel generator units shall be self-contained generating plant complete with diesel engine, alternator, control panel, mechanical coupling, base frame complete as one unit ready for installation at site. The diesel engine shall be capable of operating at 10% overload for one hour in any 12 hours in compliance with ISO 3046-2 and BS 5514 Part 2. However the generating plant shall be prime rated for the maximum load offered at the site so that 10% extra capacity is used as safety margin.

The plant shall be supplied with a factory fitted noise attenuation canopy to reduce the noise level to 85 dB at 1m when running at full load for capacity range below 1000kVA. For higher capacities open type generators shall be used with noise attenuation achieved by specially designed generator room with noise attenuators, noise proof wall and doors. The noise at one meter from any point of the room shall be less than 65dB(A). In addition the noise requirement applicable for the local area shall be met.

The system shall incorporate Manual and Automatic start and stop with provision for remote start. Load changeover arrangements shall normally be implemented in the main switchgear, however a dedicated auto changeover switch may be considered where necessary.

a) Harmonics

There will be considerable harmonic content in the load current. (Includes soft starter starting and variable frequency drives) The generator control system including AVR shall be selected so that harmonics will have no effect.

b) Motor starting

The main loads will be pumps pumping water to remote reservoirs with long pipe lines. Starters may be soft starters and motor speed may be controlled by

variable frequency drives. Therefore generator shall have high short time overload capacity.

c) Load capacity

Generator manufacturer shall carryout a generator sizing calculation using his software and ensure adequacy of the generator for starting and running all equipment under worst loading conditions.

d) Synchronisation

Synchronizing panel shall be provided for grid connected operation mode and switching elements in the switchgear may be used by coordinating with switchgear manufacturer. However electrical and mechanical interlocks to prevent back feeding, paralleling etc. shall be provided.

e) Control panel

A generator control panel shall be provided that shall incorporate the charging equipment together with all other indications and controls necessary for the automatic start, run and shut-down of the set. The control panel shall include but not be limited to the following, as separate items or as functions in a LCD touch panel display:

- Ammeter with selector switch
- Voltmeter with selector switch
- Frequency meter
- Hours-run meter
- Battery Charger Ammeter
- Oil Pressure Indicator
- Diesel Engine temperature indicator
- Annunciator System
- Start, Stop, Emergency Stop push-buttons with indicator lamps for each of these actions
- Lamp test push button
- Other functions as deemed necessary by the Manufacturer.

The annunciator system shall be provided for:

- High engine temperature
- High and low lubricating oil, pressure
- Over and under speed
- Low fuel level
- Alternator overload
- Stator winding high temperature

An industry-standard communication port shall be provided for bi-directional communication with a PLC.

f) Diesel drive engine

The engine shall be a constant speed turbo charged four stroke direct injection diesel engine, water cooled, pressure lubricated, and complying with BS 5514 rotating at 1500rpm, prime rated for operation at a maximum altitude of 100m above sea level, a maximum ambient temperature of 40 degrees centigrade, a maximum humidity of 99%, The engine shall be suitable for auto diesel grades commonly available in Bangladesh.

g) Starting

The engine shall be started from an integral 24V DC battery supply. The batteries, which shall be of the sealed lead acid type, mounted on the base frame, shall have sufficient capacity to provide five successive starts without recharging.

The batteries shall be charged by a static battery charger with intelligent charge controller complete with battery temperature monitoring.

h) Exhaust

The engine exhaust system from the engine manifold to the atmosphere shall be fabricated from stainless steel. The pipe work shall be finished in black heat-resistant paint and lagging within the building shall be 50mm thick perforated mineral wool insulated, retained by straps. The insulation shall be clad in 0.9mm thick aluminum sheet, retained by self-tapping screws or aluminum pop rivets.

The silencers shall be mounted within the plant room with exhaust protruding through the sidewall of the building

i) Fuel Supply

Bulk fuel storage tank with sufficient diesel for at least 10 days of continuous operation at the generator full load rating shall be provided satisfying the following requirements:

- Diesel feed point interface at the tanker parking bay meeting the requirements of local fuel supplier.
- Day tank as specified by the manufacturer.
- Two diesel pumps (Duty standby) for diesel transfer from tanker.
- Fuel measurement flowmeter. (Mechanical type)
- Fuel tank volume gauge based on pressure measurement with linearization.
- All piping, schedule 40 standard weight black wrought iron pipe.
- Anti pilfering measures and devices.

j) Alternator

The alternator shall be brushless, PMG type. 50Hz, conforming to BS 5000, BS 2613, BS 4999, BSEN 60034 / IEC 60034 or their latest updates. Voltage shall be as specified in the Employer's Requirement, either 0.4kV, 0.415kV or 3.3kV.

The alternator shall be suitable for continuous running duty type S1, BS 2613.

The alternator shall be equipped with anti-condensation heaters and provided with thermal over-current protection, electro-magnetic short-circuit protection, over voltage and under voltage protection.

k) Maintenance

The Contractor shall include the cost of maintenance of the plant for a period of 5 years from the date of handing over, including all non-fuel consumables such as but not limited to lubricants, filters, bearings, gaskets, etc..

l) Overhead gantry crane

The machine room housing the Diesel Generator Units shall incorporate an electrically operated overhead gantry crane conforming with sections L2-5.3.12 (b) and L2-5.6.4 of this Technical specification. The overhead gantry crane shall have the capacity to raise and transport a complete diesel generator unit to the loading and unloading bay.

m) Safety equipment

The Contractor shall provide all shields, barriers, cages, non-slip surfaces, ventilation and other protective equipment to satisfy all national and World Bank Health and Safety requirements for accident and injury prevention during the installation, assembly, operation, maintenance, servicing and dismantling of the diesel generator units.

n) Fire prevention and control

The presence of high voltage electricity, high temperature surfaces, insulated wiring, combustible fuels and lubricants and their volatiles in close proximity to each other presents an inherent fire risk. The Contractor shall ensure that the diesel generator unit enclosures and machine room are adequately ventilated to prevent the build-up of potentially flammable concentrations of volatiles, all wiring and switchgear is spark free and that potentially flammable material is kept distant from hot surfaces such as exhaust manifolds. The machine room housing the diesel generating units shall be equipped with smoke detectors, fire alarms, fire extinguishers, evacuation routes and sprinklers to prevent the spread of fire should one occur and alert operators to initiate pre-planned and regularly rehearsed fire-fighting protocols.

o) Structural specification for building and foundations

The plinths, supports and foundations carrying the diesel generating units shall be designed and constructed to withstand both the static loads of the units themselves and the dynamic loads caused by vibration and resonances emanating from the units in operation and any inertial loads transmitted to the supporting structures when the units are started and shut down.

**ANNEXURE – TECHNICAL SPECIFICATION FORMS FOR SUBMISSION
DURING BIDDING STAGE**

A small, handwritten mark or signature, possibly a stylized letter 'P' or a similar symbol, located in the bottom right corner of the page.

DUCTILE IRON (DI) PIPES AND FITTINGS



PIPES AND FITTINGS

1. Country of Manufacture: _____
2. Manufacturers' Name and Address: _____
3. Standards to which Pipes and Fittings Conform: _____
4. Certificate for Conformity to Standards Provided (Yes/No): _____
5. ISO 9001:2015 Certificate Provided (Yes/No): _____
6. Class of Pipes and Fittings: _____
7. Factory Welded Flange Pipes Tested for Each Flanged Joint (Yes/No): _____
8. Availability of Rotatable Flanges: _____
9. Are Puddle Flanges Integrally Cast?: _____
10. Whether Pipes & Fittings are from Same Manufacturer: _____
11. Standard to which Flanges Conform: _____
12. Whether Flanges are Integrally Cast or Factory Welded: _____
13. Restrained Joint Type: _____
14. Type of External Coating and Grade: _____
15. Standard for External Coating: _____
16. Internal Coating/Lining for Pipes: _____
17. Internal Coating/Lining for Fittings: _____
18. Port of Shipment: _____
19. Packing and Protection in Transit: _____
20. Catalogues / Technical Literature / Drawings Provided: _____
21. Supplier's Accredited Agent in Bangladesh: _____



GATE / SLUICE VALVES

1. Country of Manufacture: _____
2. Manufacturer's Name and Address: _____
3. Date of Manufacture: _____
4. Standards to Which Valves Conform: _____
5. Certificate for Conformity to Standards Provided: _____
6. ISO 9001:2015 Certificate Provided: _____
7. Body Material: _____
8. Spindle Material: _____
9. Metal Faces and Seal: _____
10. End Flanges – Pressure Rating: _____
11. Internal Protection: _____
12. External Protective Finish: _____
13. Packing and Protection in Transit: _____
14. Catalogues / Technical Literature / Drawings Provided: _____
15. Port of Shipment: _____
16. Supplier's Accredited Agent in Bangladesh: _____

AIR VALVES

1. Country of Manufacture: _____
2. Manufacturer's Name and Address:

3. Date of Manufacture: _____
4. ISO 9001:2015 Certificate Provided:

5. Type of Valve: _____
6. Isolating Valve with Mitre Gearing (if applicable):

7. Material of Ball: _____
8. Flange Pressure Rating: _____
9. Internal Protective Finish: _____
10. External Protective Finish: _____
11. Packing and Protection in Transit:

12. Catalogues / Technical Literature / Drawings Provided:

13. Port of Shipment: _____
14. Supplier's Agent in Bangladesh:



FIRE HYDRANTS

1. Pillar Type or Underground Type:

2. Screw Down Type: _____

3. Country of Manufacture: _____

4. Manufacturer's Name and Address:

5. ISO 9001:2015 Certificate Provided:

6. Product Conformity Certificate Provided:

7. Date of Manufacture: _____

8. Standard of Manufacture: _____

9. Inlet Flange Pressure Rating: _____

10. Direction of Closing: _____

11. Body Test Pressure: _____

12. Valve and Seat Test Pressure: _____

13. Internal Protective Finish: _____

14. External Protective Finish: _____

15. Weight: _____

16. Packing and Protection in Transit:

17. Catalogues / Technical Literature / Drawings Provided:

18. Supplier's Agent in Bangladesh:



MECHANICAL COUPLINGS AND FLANGE ADAPTERS

1. Country of Manufacture: _____

2. Manufacturer's Name and Address: _____

3. Sleeve Details (Make / Material / Standard / Date of Manufacture): _____

4. Flange Details (Make / Material / Standard / Date of Manufacture): _____

5. Gasket Details (Make / Material / Hardness / Standard / Date of Manufacture): _____

6. Joint Ring Details (Make / Material / Hardness / Standard / Date of Manufacture): _____

7. External Coating and Thickness: _____

8. Internal Coating and Lining: _____

9. Port of Shipment: _____

10. Catalogues / Technical Literature / Drawings Provided: _____

11. Supplier's Agent in Bangladesh: _____

12. ISO 9001:2015 Certificate Provided: _____



RESTRAINED MECHANICAL COUPLINGS & ACCESSORIES

1. Country of Manufacture: _____
2. Manufacturer's Name and Address: _____

3. Sleeve Details: _____
4. Flange Details: _____
5. Gasket Details: _____
6. Joint Ring Details: _____
7. External Coating and Thickness: _____
8. Internal Coating and Lining: _____
9. Port of Shipment: _____
10. Catalogues / Technical Literature / Drawings Provided: _____

11. Supplier's Agent in Bangladesh: _____

12. ISO 9001:2015 Certificate Provided: _____



SURFACE BOXES AND MANHOLE COVERS

1. Country of Manufacture: _____
2. Manufacturer's Name and Address: _____

3. ISO 9001:2015 Certificate Provided: _____

4. Material: _____
5. Manhole Cover Class / Make / Standard / Date of Manufacture: _____

6. Surface Box Class / Make / Standard / Date of Manufacture: _____

7. Coating: _____
8. Lifting Arrangements: _____
9. Supplier's Agent in Bangladesh: _____
10. Port of Shipment: _____



GASKETS & JOINT RINGS

1. Country of Manufacture: _____
2. Manufacturer's Address: _____
3. Make: _____
4. Port of Shipment: _____
5. Manufacturing Standard: _____
6. Certificate for Conformity to Standards Provided:

7. ISO 9001:2015 Certificate Provided:

8. Hardness Range: _____
9. Appearance & Finish: _____
10. Tensile Strength: _____
11. Elongation at Break: _____
12. Compression Hardness: _____
13. Protection Against Micro Biological Deterioration:

14. Non-Toxic (Yes/No): _____



NUTS, BOLTS & WASHERS

1. Country of Manufacture: _____
2. Manufacturer's Address: _____
3. Make: _____
4. Port of Shipment: _____
5. Manufacturing Standard: _____
6. Certificate for Conformity to Standards Provided:

7. ISO 9001:2015 Certificate Provided:

8. Yield Stress / Permanent Set Limit:

9. Percentage Elongation After Fracture:

10. Stress under Proof Load: _____
11. Strength under Wedge Loading: _____
12. Hardness: _____



LUBRICANT

1. Country of Manufacture: _____
2. Manufacturer's Address: _____
3. Make: _____
4. Port of Shipment: _____
5. Manufacturing Standard: _____
6. Certificate for Conformity to Standards Provided:

7. ISO 9001:2015 Certificate Provided:

8. Non-Toxic (Yes/No): _____



HDPE PIPES, FITTINGS AND ACCESSORIES

Q

HDPE PIPES

1. Country of Manufacture: _____
2. Manufacturer's Name and Address: _____
3. Manufacturing Plant Location: _____
4. Date of Manufacture: _____
5. Pipe Material Grade (PE80 / PE100 / PE100-RC): _____
6. Applicable Standard (ISO 4427 / EN 12201 / BS EN 12201): _____
7. Certificate of Conformity to Standard: _____
8. ISO 9001:2015 Certificate: _____
9. ISO 14001 Certificate: _____
10. ISO 45001 Certificate: _____
11. Nominal Diameter Range: _____
12. SDR Class: _____
13. Pressure Rating (PN): _____
14. Design Life: _____
15. Minimum Required Strength (MRS): _____
16. Melt Flow Index (MFI): _____
17. Carbon Black Content: _____
18. Carbon Black Dispersion: _____
19. UV Stabilisation: _____
20. Pipe Colour: _____
21. Marking Details on Pipe: _____
22. Hydrostatic Strength Compliance: _____
23. Resistance to Crack Propagation: _____
24. Resistance to Slow Crack Growth: _____
25. Ovality Tolerance: _____
26. Wall Thickness Tolerance: _____
27. Third Party Certification Available: _____



28. Factory Production Control Procedures:

29. Type Testing Reports Available:

30. Routine Testing Procedures: _____

31. Packing and Protection in Transit:

32. Port of Shipment: _____

33. Technical Literature Submitted: _____

34. Supplier's Local Agent: _____



HDPE INJECTION MOULDED / FABRICATED SPECIALS

1. Country of Manufacture: _____
2. Manufacturer's Name and Address: _____

3. Type of Fitting: _____
4. Material Grade: _____
5. Applicable Standard: _____
6. ISO 9001:2015 Certification: _____
7. SDR Class: _____
8. Pressure Rating (PN): _____
9. Injection Moulded or Fabricated: _____
10. Welding Method Used: _____
11. Visual Inspection Procedures: _____
12. Dimensional Tolerance Compliance: _____

13. Hydrostatic Strength Compliance: _____

14. Factory Testing Procedures: _____
15. Traceability Marking: _____
16. Technical Literature Submitted: _____
17. Packing and Protection: _____
18. Port of Shipment: _____
19. Supplier's Local Agent: _____



ELECTROFUSION FITTINGS

1. Country of Manufacture: _____
2. Manufacturer's Name and Address: _____

3. Type of Fitting: _____
4. Material Grade: _____
5. Applicable Standard: _____
6. ISO 9001:2015 Certification: _____
7. SDR Compatibility: _____
8. Pressure Rating (PN): _____
9. Barcode System Available: _____
10. Traceability System Available: _____
11. Fusion Indicator Provided: _____
12. Embedded Heating Wire Material: _____

13. Operating Voltage: _____
14. Fusion Control Parameters: _____
15. Temperature Compensation Feature: _____

16. Visual Fusion Indicator: _____
17. Peelable Label Available: _____
18. Batch Identification System: _____
19. Hydrostatic Strength Compliance: _____

20. Type Test Reports Available: _____
21. Routine Factory Testing: _____
22. Technical Literature Submitted: _____
23. Packing and Protection: _____
24. Port of Shipment: _____
25. Supplier's Local Agent: _____



BUTT FUSION FITTINGS

1. Country of Manufacture: _____
2. Manufacturer's Name and Address: _____

3. Type of Fitting: _____
4. Material Grade: _____
5. Applicable Standard: _____
6. ISO 9001:2015 Certification: _____
7. SDR Compatibility: _____
8. Pressure Rating (PN): _____
9. Manufacturing Method: _____
10. Injection Moulded or Fabricated: _____

11. Dimensional Compliance: _____
12. Hydrostatic Strength Compliance: _____

13. Slow Crack Growth Resistance: _____
14. Traceability Marking: _____
15. Factory Testing Procedures: _____
16. Type Test Reports Available: _____
17. Technical Literature Submitted: _____
18. Packing and Protection: _____
19. Port of Shipment: _____
20. Supplier's Local Agent: _____



SERVICE CONNECTIONS, TAPPING SADDLES AND ACCESSORIES

1. Country of Manufacture: _____
2. Manufacturer's Name and Address: _____

3. Type of Saddle: _____
4. Material of Saddle Body: _____
5. Material of Clamping Bands: _____
6. Material of Bolts and Nuts: _____
7. Gasket Material: _____
8. Applicable Standard: _____
9. ISO 9001:2015 Certification: _____
10. Pressure Rating (PN): _____
11. Outlet Connection Type: _____
12. Outlet Thread Standard: _____
13. Corrosion Protection System: _____
14. Stainless Steel Grade of Fasteners: _____

15. Resistance to Pull-Out Forces: _____
16. Leakage Test Compliance: _____
17. Hydrostatic Pressure Test Compliance: _____

18. Suitability for HDPE Pipe Material: _____

19. Factory Testing Procedures: _____
20. Technical Literature Submitted: _____
21. Packing and Protection: _____
22. Port of Shipment: _____
23. Supplier's Local Agent: _____

MECHANICAL EQUIPMENT

Double Suction Split Case Centrifugal Pumps

Item No	Description	Bidder's Response
1. Pump		
1	Manufacturer	
2	Country of manufacture	
3	Country of Origin	
4	Local Agents	
5	Manufacturer's Model Number	
6	Type	
7	Number of units (duty + standby)	
8	Duty flow each pump (m ³ /h)	
9	Design duty head (m)	
10	Number of stages	
11	Speed (rpm)	
12	Range of stable system operation expected m ³ /h	
13	Shut off Head (m)	
14	Duty efficiency (%)	
15	Pump duty power requirement (kW)	
16	Size of flywheel (WR ² : kg·m ²)	
17	Inlet Diameter (mm)	
18	Outlet Diameter (mm)	
19	Pump materials: Casing	
20	Impeller	
21	Whether the acceptance Grade "1U" according to latest ISO 9906 is confirmed.	
22	Design life	
23	Free Passage (mm)	
24	Seal Type	
25	Service life of bearings – L 10 life time	
26	Suction and Discharge flange standard	



Item No	Description	Bidder's Response
27	Shaft material	
28	Coating system applied (external)	
29	Coating system applied (Internal)	
30	Maximum noise level guaranteed at 1m.	
31	Direction of rotation	
32	Catalogues, technical literature, certificates, etc. attached (Yes/No)	
2. Motor		
1	Manufacturer	
2	Country of manufacture	
3	Country of Origin	
4	Local Agents	
5	Manufacturer's Model Number	
6	Type	
7	Rated power (kW)	
8	Voltage (V)	
9	Power factor at 100% rated load	
10	Full load speed (rpm)	
11	Class of Insulation	
12	Efficiency at 100% rated power (%)	
13	Number of starts per hour	
14	Whether the motor is compatible for VSD Operation	
15	Motor Encloser protection (IP rating)	
16	Maximum temperature rises with VSD operation	
17	Available sensors and protection devices	
18	Design life	
19	Service life of bearings – L 10 life time	
20	Catalogues, technical literature, certificates, etc. attached (Yes/No)	



Surge Vessel

Item No	Description	Bidder's Response
1	Manufacturer	
2	Country of manufacture	
3	Country of Origin	
4	Manufacturer's Model Number	
5	Type	
6	Volume of vessel (m ³) x Number	_____ m ³ x ____ no. / _____ m ³ x no.
7	Maximum Working Pressure	/
8	Adjustable Pressure Range	/
9	Materials: Vessel	
10	Bladder	
11	Catalogues, technical literature, certificates, etc.	
12	Design life	
13	The available system for bladder failure detection (air side)	
14	Water level switches	
15	Manhole size	
16	Accessories	
17	Confirm whether the all parts contact with the water are food grade	
18	Bladder anti-suction protection	
19	Material of nut and bolts	
20	Internal coating /corrosion protection	
21	External coating /corrosion protection	
22	Catalogues, technical literature, certificates, etc. attached (Yes/No)	

Submersible Pumps

Item No	Description	Bidder's Response
1	Manufacturer	
2	Country of manufacture	
3	Country of Origin	
4	Local Agents	
5	Manufacturer's Model Number	
6	Type	
7	Duty flow each pump (m ³ /h)	
8	Design duty head (m)	
9	Motor output (kW)	
10	Outlet Diameter (mm)	
11	Pump materials: Casing	
12	Impeller	
13	Catalogues, technical literature, certificates, etc. attached (Yes/No)	

Sump Pumps

Item No	Description	Bidder's Response
1	Manufacturer	
2	Country of manufacture	
3	Country of Origin	
4	Local Agents	
5	Manufacturer's Model Number	
6	Type	
7	Duty flow each pump (m ³ /h)	
8	Design duty head (m)	
9	Motor output (kW)	
10	Outlet Diameter (mm)	

Item No	Description	Bidder's Response
11	Pump materials: Casing	
12	Impeller	
13	Catalogues, technical literature, certificates, etc. attached (Yes/No)	

Service Water Pumps (Package Unit)

Item No	Description	Bidder's Response
1	Manufacturer	
2	Country of manufacture	
3	Country of Origin	
4	Manufacturer's Model Number	
5	Max flow (m ³ /hr)	
6	Max operation pressure (m)	
7	Number of pumps	
8	Volume of pressure tank	
9	Catalogues, technical literature, certificates, etc. attached (Yes/No)	
Local Control Panel		
10	Make	
11	Country of origin	
12	Country of manufacture	
13	Make and model of VSDs	
14	Manufacturer, make and model of PLC or any other controller.	
15	Available protection devices	
16	Accessories	
17	Catalogues, technical literature, certificates, etc. attached (Yes/No)	

Filter Underdrain System

Item No	Description	Bidder's Response
1	Manufacturer	
2	Country of manufacture	
3	Country of Origin	
4	Manufacturer's Model Number	
5	Type (Monolithic construction)	
6	Material: Floor slab	
7	Nozzles	
8	Support	
9	Weight (kg/m ²)	
10	Maximum upward design pressure (m water)	
11	Maximum downward design pressure (m water)	
12	Catalogues, technical literature, certificates, etc. attached (Yes/No)	

Chemical Pumps (Alum)

Item No	Description	Bidder's Response
1	Manufacturer	
2	Country of manufacture	
3	Country of Origin	
4	Manufacturer's Model Number	
5	Materials	
6	Catalogues, technical literature certificates, etc. (Yes/No)	

Chemical Pumps (Lime)

Item No	Description	Bidder's Response
1	Manufacturer	
2	Country of manufacture	
3	Country of Origin	
4	Manufacturer's Model Number	
5	Materials	
6	Catalogues, technical literature certificates, etc. (Yes/No)	

Chemical Pumps (PAC)

Item No	Description	Bidder's Response
1	Manufacturer	
2	Country of manufacture	
3	Country of Origin	
4	Manufacturer's Model Number	
5	Materials	
6	Catalogues, technical literature certificates, etc. (Yes/No)	

Butterfly Valve

Item No	Description	Bidder's Response
1. Butterfly Valve		
1	Country of Manufacture	
2	Manufacturer's Name and Address	
3	Country of Origin	
4	Standards to which Valves Conform	
5	Is ISO 9001: 2015 Quality Management System Certificate Provided to the Factory/ Factories	
6	Is Certificate for Conformity to Standards from Relevant Standard Institution Provided to the Factory/	

Item No	Description	Bidder's Response
	Factories	
7	Material	
	Valve Body	
	Valve Disc	
	Valve Seat	
	Shaft	
	Shaft Seals	
8	Valve body: Whether Rubber Lined? If so Material	
9	Standards to which Gaskets Conforms	
10	Is Certificate for Conformity to Standards from Relevant Standard Institution Provided to Gaskets	
11	Is ISO 9001: 2015 Quality Management System Certificate Provided to the Factory/ Factories	
12	Face to Face Dimensions of the Valves (mm)	
13	End Flanges	
	Pressure Rating	
	Dimensions (mm)	
	Bolt circle dia (mm)	
14	Standard to Which Nuts and Bolts Conform and the Material	
15	The Type of Operating Gear for the Valve	
16	Operating Method of the Valve (Hand Wheel/Tee key)	
17	Whether Gearing Arrangement is Provided	
	Gear Ratio of Gearing	
	Unbalanced Head	Bars
	Seat Test Pressure	Bars
	Body Test Pressure	Bars
18	Internal Protective Finish Material	

Item No	Description	Bidder's Response
	Thickness	
19	External Protective Finish Material Thickness	
20	Weight of the Valve	kg
21	Packing and Protection of Valves in Transit	
22	Reference of the Catalogues, Technical Literature and Drawings Provided with the Bid	
23	Port of Shipment	
24	Time of Delivery of Valves at Port of Shipment	
25	Name and Address of Supplier's Agent (If any) in Bangladesh	
26	Deviations from Specifications (If any)	
2. Actuator (for motorized)		
1	Manufacturer	
2	Country of manufacture	
3	Country of Origin	
4	Manufacturer's Model Number	
5	Motor output (kW)	
3. Limit switch indication box (for hand-operated)		
1	Manufacturer	
2	Country of manufacture	
3	Country of Origin	
4	Manufacturer's Model Number	
5	Catalogues, technical literature, certificates, etc. attached (Yes/No)	

Note: Fill separate sheets for all different types of butterfly valves

Check Valve

Item No	Description	Bidder's Response
1	Manufacturer	
2	Country of manufacture	
3	Country of Origin	
4	Manufacturer's Model Number	
5	Type	
6	Manufacturing standard	
7	Materials: Body	
8	Disc	
9	Catalogues, technical literature, certificates, etc. attached (Yes/No)	

Note: Fill separate sheet for different type of check valves



ELECTRICAL

LV SWITCHGEAR PANELS

Item No	Description	Bidder's Response
1. Complete panel		
1	Manufacturer	
2	Country of Origin	
3	Country of manufacture	
4	Address of Factory	
5	Name & Address of Local Agent (If not manufactured in Bangladesh)	
6	Attach type certificates	
7	Catalogues, technical literature, certificates, etc. attached (Yes/No)	
2. Panel enclosure		
1	Make	
2	Country of manufacture	
3	Selected model / series	
4	Address of Manufacturing facility	
5	Attach type test certificates	
6	Catalogues, technical literature, certificates, etc. attached (Yes/No)	
3. ACB		
1	Make	
2	Country of manufacture	
3	Selected model / series	
4	Catalogues, technical literature, certificates, etc. attached (Yes/No)	
4. MCCB		
1	Make	

Item No	Description	Bidder's Response
2	Country of manufacture	
3	Selected model / series	
4	Catalogues, technical literature, certificates, etc. attached (Yes/No)	
5. Protection and monitoring relays		
1	Make	
2	Country of manufacture	
3	Selected models	
4	Catalogues, technical literature, certificates, etc. attached (Yes/No)	
6. Indicating instruments		
1	Make	
2	Country of manufacture	
3	Catalogues, technical literature, certificates, etc. attached (Yes/No)	

MCC

Item No	Description	Bidder's Response
1. Complete panel		
1	Manufacturer	
2	Country of Origin	
3	Country of manufacture	
4	Address of Factory	
5	Name & Address of Local Agent (If not manufactured in Bangladesh)	
6	Attach type approval certificates	
7	Catalogues, technical literature, certificates, etc. attached (Yes/No)	
2. VFD (For MCC panel mounted)		
1	Manufacturer	
2	Country of Origin	

Item No	Description	Bidder's Response
3	Country of manufacture	
4	Selected model /series	
5	Make of Active Harmonic Filter (AHF)	
6	Country of origin of AHF	
7	Model number of AHF	
8	Name & Address of Local Agent for VFD and AHF	
9	Catalogues, technical literature, certificates, etc. attached (Yes/No)	
3. Soft starter		
1	Manufacturer	
2	Country of Origin	
3	Country of manufacture	
4	Selected model /series	
5	Name & Address of Local Agent	
6	Catalogues, technical literature, certificates, etc. attached (Yes/No)	
4. Contactors		
1	Manufacturer	
2	Country of Origin	
3	Country of manufacture	
4	Selected model /series	
5	Name & Address of Local Agent	
6	Catalogues, technical literature, certificates, etc. attached (Yes/No)	
5. MCCB		
1	Make	
2	Country of origin	
3	Country of manufacture	
4	Selected model / series	
5	Catalogues, technical literature, certificates, etc. attached (Yes/No)	
6. Protection and monitoring relays		
1	Make	

Item No	Description	Bidder's Response
2	Country of manufacture	
3	Selected models	
4	Catalogues, technical literature, certificates, etc. attached (Yes/No)	
7. Indicating instruments		
1	Make	
2	Country of origin	
3	Country of manufacture	
4	Catalogues, technical literature, certificates, etc. attached (Yes/No)	

VFD

Item No	Description	Bidder's Response
1	Make	
2	Country of origin	
3	Country of manufacture	
4	IEC standard (Pl. attach conformity certificate)	
5	Selected model /series	
6	Rated capacity (kW)	
7	Total harmonic current (THDi) (%)	
8	Overall efficiency (%)	
9	Name & Address of Local Agent	
10	Is type approval certificates available. (Attach copy of certificate)	
11	Catalogues, technical literature, certificates, etc. attached (Yes/No)	

LOCAL OPERATION STATIONS

Item No	Description	Bidder's Response
1	Make	
2	Country of origin	
3	Country of manufacture	
4	Enclosure material	
5	Beading material	
6	Catalogues, technical literature, certificates, etc. attached (Yes/No)	

CABLES

Item No	Description	Bidder's Response
1. Power cables / control cables		
1	Make	
2	Country of origin	
3	Country of manufacture	
4	Applicable IEC standard (Pl. attach conformity certificate)	
5	Catalogues, technical literature, certificates, etc. attached (Yes/No)	
2. VFD Motor cables		
1	Make	
2	Country of origin	
3	Country of manufacture	
4	Applicable IEC standard (Pl. attach conformity certificate)	
5	Catalogues, technical literature, certificates, etc. attached (Yes/No)	
3. Instrumentation cables		
1	Make	
2	Country of origin	
3	Country of manufacture	

Item No	Description	Bidder's Response
4	Applicable IEC standard (Pl. attach conformity certificate)	
5	Catalogues, technical literature, certificates, etc. attached (Yes/No)	

CABLE SUPPORT SYSTEM

Item No	Description	Bidder's Response
1. Cable ladders		
1	Make	
2	Country of manufacture	
3	Catalogues, technical literature, certificates, etc. attached (Yes/No)	
2. Cable trays		
1	Make	
2	Country of origin	
3	Catalogues, technical literature, certificates, etc. attached (Yes/No)	

HV Switch Gear and Panels

Item No	Description	Bidder's Response
1	Manufacturer	
2	Country of Origin	
3	Country of manufacture	
4	Name & Address of Local Agent	
5	Applicable IEC standard (Pl. attach conformity certificate)	
6	Catalogues, technical literature, certificates, etc. attached (Yes/No)	



Power Transformers

Item No	Description	Bidder's Response
1	Manufacturer	
2	Country of Origin	
3	Country of manufacture	
4	Name & Address of Local Agent	
5	Applicable IEC standard (Pl. attach conformity certificate)	
6	Catalogues, technical literature, certificates, etc. attached (Yes/No)	

HV Cables

Item No	Description	Bidder's Response
1	Manufacturer	
2	Country of Origin	
3	Country of manufacture	
4	Name & Address of Local Agent	
5	Applicable IEC standard (Pl. attach conformity certificate)	
6	Catalogues, technical literature, certificates, etc. attached (Yes/No)	

Instrumentation Cables

Item No	Description	Bidder's Response
1	Manufacturer	
2	Country of Origin	
3	Country of manufacture	
4	Name & Address of Local Agent	
5	Applicable IEC standard (Pl. attach conformity certificate)	
6	Catalogues, technical literature, certificates, etc. attached (Yes/No)	



SCADA AND INSTRUMENTATION

Operator Station SCADA

Item No	Description	Bidder's Response
1	Manufacturer	
2	Country of Origin	
3	Country of Manufacture	
4	Operation System	
5	CPU Model No.	
6	CPU Base Frequency (GHz)	
7	Storage Capacity (GB)	
8	Monitor Size	
9	Monitor Resolution	
10	Catalogues, technical literature, certificates, etc. attached (Yes/No)	

Functions for SCADA

Item No	Description	Bidder's Response
1	Monitor and Control Display Function (yes/no)	
2	Plant Monitoring Display Function (yes/no)	
3	Trend Display Function (yes/no)	
4	Tuning Display Function (yes/no)	
5	Alarm Display Function (yes/no)	
6	System Condition Display (yes/no)	
7	Control Progress Display (yes/no)	
8	Security Function (yes/no)	
9	Self-Diagnosis Function (yes/no)	



SCADA Software

Item No	Description	Bidder's Response
1	Name of software	
2	Country of Origin	
3	Name & Address of Local Agent	

SCADA System configuration and programming

Item No	Description	Bidder's Response
1	Name of company	
2	Country of registration	
3	Name & Address of Local Agent (If not manufactured in Bangladesh)	
4	Company profile- Pl attach	
5	Company past experience -Pl attach Third Party certificates	

PLC for SCADA

Item No	Description	Bidder's Response
1	Make of PLC	
2	Country of origin	
3	Country of manufacture	
4	Model/ series	
5	Name & Address of Local Agent	
6	Company profile- Pl attach	
7	Company past experience -Pl attach Third Party certificates	
8	Catalogues, technical literature, certificates, etc. attached (Yes/No)	



**PLC configuration, programming, design and construction of ICA panel,
Filter Control Panel, Sludge Drain Valve Control Panel for SCADA**

Item No	Description	Bidder's Response
1	Name of company	
2	Country of registration	
3	Name & Address of Local Agent (If not manufactured in Bangladesh)	
4	Company profile- Pl attach	
5	Company past experience -Pl attach Third Party certificates	

Compact PLC for SCADA

Item No	Description	Bidder's Response
1	Manufacturer	
2	Country of Origin	
3	Country of Manufacture	
4	Name & Address of Local Agent	
5	Address of Manufacturing facility	
6	Type approval certificates (Attach copy of certificate)	
7	Model/ series	
8	Catalogues, technical literature, certificates, etc. attached (Yes/No)	

UPS for SCADA

Item No	Description	Bidder's Response
1	Manufacturer	
2	Country of Origin	
3	Model/ series	

4	Country of Manufacture	
5	Name & Address of Local Agent	
6	Catalogues, technical literature, certificates, etc. attached (Yes/No)	

Instrumentation cables for SCADA

Item No	Description	Bidder's Response
1	Manufacturer	
2	Country of Origin	
3	Country of Manufacture	
4	Catalogues, technical literature, certificates, etc. attached (Yes/No)	

Fibre Optic Cable for SCADA

Item No	Description	Bidder's Response
1	Manufacturer	
2	Country of Origin	
3	Country of Manufacture	
4	Catalogues, technical literature, certificates, etc. attached (Yes/No)	

Electromagnetic flow meters (FIT)

Item No	Description	Bidder's Response
1	Manufacturer	
2	Country of Origin	
3	Country of Manufacture	
4	Name & Address of Local Agent	
5	Selected series	

Item No	Description	Bidder's Response
6	Catalogues, technical literature, certificates, etc. attached (Yes/No)	

Level transmitters (LIT) - Ultrasonic type

Item No	Description	Bidder's Response
1	Manufacturer	
2	Country of Origin	
3	Country of Manufacture	
4	Name & Address of Local Agent	
5	Selected series	
6	Catalogues, technical literature, certificates, etc. attached (Yes/No)	

Level transmitters (LIT) - Pressure sensing type

Item No	Description	Bidder's Response
1	Manufacturer	
2	Country of Origin	
3	Country of Manufacture	
4	Name & Address of Local Agent	
5	Selected series	
6	Catalogues, technical literature, certificates, etc. attached (Yes/No)	

Level transmitters (LIT) - Submersible capsule type

Item No	Description	Bidder's Response
1	Manufacturer	
2	Country of Origin	
3	Country of Manufacture	
4	Name & Address of Local Agent	
5	Model / series	
6	Catalogues, technical literature, certificates, etc. attached (Yes/No)	

Level switch (LS) - Float type

Item No	Description	Bidder's Response
1	Manufacturer	
2	Country of Origin	
3	Country of Manufacture	
4	Name & Address of Local Agent	
5	Model / series	
6	Catalogues, technical literature, certificates, etc. attached (Yes/No)	

Level switch (LS) - Electrode type

Item No	Description	Bidder's Response
1	Manufacturer	
2	Country of Origin	
3	Country of Manufacture	
4	Name & Address of Local Agent	
5	Model / series	

Item No	Description	Bidder's Response
6	Catalogues, technical literature, certificates, etc. attached (Yes/No)	

Pressure Transmitters (PIT)

Item No	Description	Bidder's Response
1	Manufacturer	
2	Country of Origin	
3	Country of Manufacture	
4	Name & Address of Local Agent	
5	Address of Manufacturing facility	
6	Model / series	
7	Catalogues, technical literature, certificates, etc. attached (Yes/No)	

Differential Pressure Transmitters (DPT)

Item No	Description	Bidder's Response
1	Manufacturer	
2	Country of Origin	
3	Country of Manufacture	
4	Name & Address of Local Agent	
5	Model / series	
6	Catalogues, technical literature, certificates, etc. attached (Yes/No)	



Pressure Switch (PS)

Item No	Description	Bidder's Response
1	Manufacturer	
2	Country of Origin	
3	Country of Manufacture	
4	Name & Address of Local Agent	
5	Model / series	
6	Catalogues, technical literature, certificates, etc. attached (Yes/No)	

Density Indicating Transmitter

Item No	Description	Bidder's Response
1	Manufacturer	
2	Country of Origin	
3	Country of Manufacture	
4	Name & Address of Local Agent	
5	Model / series	
6	Catalogues, technical literature, certificates, etc. attached (Yes/No)	

Blanket Detecting Transmitter

Item No	Description	Bidder's Response
1	Manufacturer	
2	Country of Origin	
3	Country of Manufacture	
4	Name & Address of Local Agent	
5	Model / series	

6	Catalogues, technical literature, certificates, etc. attached (Yes/No)	
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Level Transmitters (LIT) – Radar type

Item No	Description	Bidder's Response
1	Manufacturer	
2	Country of Origin	
3	Country of Manufacture	
4	Name & Address of Local Agent	
5	Address of Manufacturing facility	
6	Model / series	
7	Catalogues, technical literature, certificates, etc. attached (Yes/No)	

Large Screen – LCD Display

Item No	Description	Bidder's Response
1	Manufacturer	
2	Country of Origin	
3	Country of Manufacture	
4	Name & Address of Local Agent	
5	Address of Manufacturing facility	
6	Model / series	
7	Catalogues, technical literature, certificates, etc. attached (Yes/No)	

SCADA hardware like combined server, Historian server, Operator stations etc.

Item No	Description	Bidder's Response
1	Manufacturer	
2	Country of Origin	
3	Country of Manufacture	
4	Name & Address of Local Agent	
5	Address of Manufacturing facility	
6	Model / series	
7	Catalogues, technical literature, certificates, etc. attached (Yes/No)	



